BEFORE THE ENVIRONMENT COURT

In the matter of	appeals under clause 14 of the First Schedule to the Resource Management Act 1991 concerning proposed One Plan for the Manawatu-Wanganui region.
between	**FEDERATED FARMERS OF NEW ZEALAND ENV-2010-WLG-000148**
and	**MERIDIAN ENERGY LTD** **ENV-2010-WLG-000149**
and	**MINISTER OF CONSERVATION** **ENV-2010-WLG-000150**
and	**PROPERTY RIGHTS IN NEW ZEALAND** **ENV-2010-WLG-000152**
and	**HORTICULTURE NEW ZEALAND** **ENV-2010-WLG-000155**
and	**WELLINGTON FISH & GAME COUNCIL** **ENV-2010-WLG-000157**
	Appellants
and	**MANAWATU-WANGANUI REGIONAL COUNCIL** *Respondent*

STATEMENT OF TECHNICAL EVIDENCE BY GARTH OLIVER EYLES ON THE TOPIC OF SUSTAINABLE LAND USE AND ACCELERATED EROSION ON BEHALF OF WELLINGTON FISH & GAME COUNCIL

Dated: 17 February 2012

MY QUALIFICATIONS AND EXPERIENCE RELATIVE TO THIS EVIDENCE

1. My Full Name is Garth Oliver Eyles. I am a consultant working on my own behalf., I have a B Sc and Dip Ag Sci, am an Honorary Member of The New Zealand Association of Resource Management (NZARM), was registered CpAg prior to retirement, and currently hold a NZARM Professional Certificate and Practising Certificate I was awarded a Green Ribbon from Ministry for the Environment in 2009 for my work in sustainable land management.

2. From 1965 till 1993 I was involved with a number of projects in the Manawatu Wanganui region. In 1967 I was part of a team which undertook a reconnaissance Land Use Capability Survey of the Wanganui catchment to identify whether it should become part of the Taranaki or Manawatu Catchment Authority. From 1976 to 1992 I was based in Palmerston North and at the Aokoutere Science Centre, outside Palmerston North, employed by Ministry of Works and Development (MWD) and, for a short time, by Landcare Research. During this time I progressed from field mapping as a farm advisor, to scientist, leading the land resources group. I was involved with land use capability assessment at the national, regional and local levels with projects ranging from developing LUC maps for farm plans of development blocks, catchment studies and national mapping programmes. I correlated the New Zealand Erosion Map series in the 1970s, assessing potential erosion severity as well as identifying actual erosion at 1:250,000 scale. This comprised present erosion, potential erosion and erosion associations. Maps covered the Manawatu-Wanganui area. I was involved with developing the classifications for the New Zealand Land Resource Inventory (NZLRI), and writing the descriptive bulletin for the erosion classification, (Eyles, 1985). I managed the North Island mapping programme for the NZLRI and later for the whole of New Zealand and was responsible for maintaining the national standards. This included supervising the development of the Manawatu-Taranaki Land Use Capability Classification (Fletcher, 1987), still used today as a basis for farm plan mapping in the region, and field checking most of the one mile to one inch scale worksheets in the region prior to printing and GIS inputting. In 1992, together with Dennis Hocking representing Federated Farmers, we organised an erosion survey, with Dr Doug Hicks,

following the erosion events in the Manawatu Rangitikei area that year. I was an author of the report. (Hicks et al., 1993). Following the 2004 storm I was a member of a government committee allocating funds for the rehabilitation of non scheme stopbanks in the Manawatu-Wanganui Regional Council's region. I have been a speaker at a number of Farm Forestry field days in the area.

3. In 1993 I joined Hawke's Bay Regional Council as Manager Land Management, a position I held until retirement in 2008. During this time I continued working on developing and implementing erosion control programmes and farm planning as part of Council's non regulatory component of their Regional Plan. Council was keen to work with, rather than regulate, farmers to ensure development had minimal off-site effects. Whole farm plans were one of the measures offered to hill country farmers with eight per year being budgeted for through an in-house management system. These plans evolved from the traditional assessing of erosion and its prevention to whole farm plans dealing with development and biodiversity protection. I was the project Coordinator for the Pakuratahi Land Use Study, a 13 year paired catchment study jointly funded by HBRC and the forest industry which compared the environmental effects of commercial forestry and pastoral farming through various phases of the forest rotation.

4. During my career I also worked on projects overseas – a three year ODA programme in Indonesia introducing our land use capability system to highly erodible catchments with the Indonesian Ministry of Forestry, reviewing soil erosion in the South Pacific for the University of the South Pacific (USP), running a small catchment mapping seminar series in Brazil for FAO, and preparing a World Bank Loan for Santa Catarina State in Brazil to improve small catchment management systems.

5. Since 1968 to the present time most Land Management Advisory staff in New Zealand have been through Land Use Capability (LUC) training courses I have either directed or been involved with organising and presenting. I was a co author of the 3rd Edition Land Use Capability Survey Handbook printed in 2009 (Lynn et al., 2009), and was invited to write the Preface. I have authored a considerable number of academic papers and popular articles on land use capability and the sustainable use of land.

6. Projects I have worked on since my retirement from the Council in 2008 include involvement in 2009 with a national workshop series on land use capability in eight regions, and one in 2010 for the North Island on soil erosion. These were both funded by the Ministry of Agriculture and Fisheries and both included workshops in the Manawatu-Wanganui area. I monitored year one of the Manawatu-Wanganui Regional Council's farm planning programme, have been personally involved with the preparation of two farm plans in the Akitio area and one in the Taihape area as part of the SLUI programme and have been involved with training a number of Manawatu-Wanganui Regional Council staff in LUC assessment.

7. I am currently working with a local Hawke's Bay forest company investigating whether detailed LUC maps of forest blocks could be beneficial in reducing the off-site effects of sediment and tree debris deposition.

8. I am currently a Trustee of the Poplar and Willow Research Trust. This was established in 2011 to ensure the long term breeding programmes, essential for the sustainable development of our hill country, are adequately funded and appropriately directed. The Manawatu-Wanganui Regional Council is a party to this Trust. I am also a member of the Wellington Hawke's Bay Conservation Board.

9. I am familiar with the evidence of those witnesses relevant to my area of expertise which is contained in the "Technical Evidence Bundle" lodged with the Court by the respondent, together with the additional evidence of Mr P Hindrup, Dr J Quinn and Mr A Kirk dated 31 January 2012

10. I attended expert witness conferencing on 7 February 2012. At the time of writing this evidence no agreed record of that conferencing has been produced.

11. I have read the Environment Court's practice note 'Expert Witness – Code of Conduct' and I agree to comply with it. I confirm that the issues addressed in this brief are within my areas of expertise.

12. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SCOPE OF EVIDENCE

13. My evidence will deal with the following:

- Land management and the Land Management Officer
- The use of the terms accelerated erosion and natural erosion.
- How the land use capability classification addresses the erosion factor.
- Critical slope criteria
- The importance of land use capability mapping at farm scale, as a first step in working towards sustainable land management for pastoral agriculture.
- The importance of riparian management in achieving both on-site and off-site benefits.
- Specific comments on rules relating to vegetation clearance and cultivation.

EXECUTIVE SUMMARY

- Based on 45 years of experience in the field it is my opinion that the distinction between natural and accelerated erosion is meaningless. It is mostly impossible to clearly differentiate between the two in the field and the distinction is not even considered when planning to control erosion through soil conservation practices. I recommend the terms '*accelerated*' and '*natural*' not be used and that they be replaced by the term '*erosion*'.

- Land use capability is the systematic arrangement of different types of land according to those properties that determine its capacity for long term, sustained production. It is a very powerful planning tool which is the cornerstone of soil conservation planning. In my opinion, the Land Use Capability (LUC)

Classification system used in the Manawatu-Wanganui Regional Council's farm plans is ideal as a base for 'Objectives' and regulatory framework within the plan, but it has not been used anywhere near its potential.

- I recommend the reinstatement of an appropriate map/ access to GIS layers within the council website to illustrate LUC classes and units at an elevated risk of erosion in the region, including those which are currently under vegetation cover. The appropriate LUC classes and units should be referenced within and provide the basis for the regulatory framework. Management/ regulatory approaches established in the Plan should be targeted at the appropriate land.

- The proposed One Plan uses the slope angle of 28^0 to define the critical slope angle for an increased risk of erosion. This threshold is both inappropriate in that it fails to adequately account for earthflow and gully erosion, and is also incompatible with the slope grouping used for LUC mapping and WFBP, which use nationally consistent slope groupings.

- My preferred option for appropriate slope standards is that the map of erosion management areas be reinstated. However, if a single slope angle is to be used, I recommend that it be 20^0, based on DeRose's (1995) review, rather than the much higher 28^0 in the proposed One Plan, as it takes a more precautionary approach and will address earthflow, gully, and landslide erosion. Establishment of 20^0 slope standard will obviate the need to re map the region identifying the 28^0 line as the 20^0 limit is already mapped in the NZLRI sheets and in each WFBP.

- The establishment of WFBP is the cornerstone in any progressive regional plan. The WFBP provides an independent assessment of the sustainability of each part of a farm property. It identifies areas where development can be increased, areas where development needs to be considered carefully and may need a change in land use, where development may need space planted erosion control trees, or where a change to a commercial timber plantation may be preferable, and areas

which need to be retired. These will vary depending on the individual farm. Occasionally, a plan will indicate to a farmer that the property has too many limitations to be economically viable, but that is information that allows the farmer to be pro-active in making long term decisions such as selling or adding to the block. More frequently, it identifies where development may occur, and assists the farmer in developing a resilient property.

- The alternative to the whole farm plan approach is to look at single issues, and regulate accordingly.

- Land disturbance, cultivation, and vegetation clearance can have adverse effects on the environment.

- Cultivation on hill country properties which are undertaken in accordance with an operational WFBP could be a permitted activity, as long as appropriate setback distances are applied, as the appropriateness of the activity would have been assessed by LMO. For properties without a WFBP, LUC Classes 5, 6 and 7 or slopes greater than 20^0, I would recommend regulated through the consenting process.

- The Hill Country Erosion Management Areas are best protected by native forest. Removal of this vegetation, to be replaced by pasture, is likely to lead to increased risk of erosion. It is, therefore, important for the proposed One Plan to ensure any clearance of this cover is carefully managed and only occurs where it is safe to do so. Any proposed clearance of mature forest, on land identified as at risk of erosion should be assessed by a LMO to allow an assessment of the appropriateness and likely effects of the activity under a consent or through WFBP.

- The retention of riparian vegetation, especially willow vegetation is essential in stabilising stream bank erosion in high energy systems. Stream bank erosion is a major source of sediment in many of the high sediment generating catchments.

Riparian vegetation especially native vegetation, together with grasses and other low vegetation also provide a positive nutrient filtering system.

LAND MANAGEMENT AND LAND MANAGEMENT OFFICERS

14. Land Management (in the past called soil conservation) was introduced under the 1941 Water and Soil Conservation Act to 'make provision for the conservation of soil resources and for the prevention of damage by soil erosion' (McCaskill, 1973). This was considered necessary as soil erosion rates, especially in hill country, were becoming serious and flooding was very damaging. Until the establishment of regional councils, central government, through MWD and National Water and Soil Conservation Organisation (NWASCO) played a central role by providing financial grants for accepted work programmes and by maintaining professional standards through soil conservator (Land Management) staff training. Farm planning was a core activity as it provided the understanding of the physical status of a property allowing management systems to be introduced to reduce the risk of erosion. The tools available to reduce erosion were: temporary retirement (from grazing) to allow pasture renewal, permanent retirement, conversion to closed canopy tree cover, spaced planting of poplars or willows in pasture, regenerating pasture and changing grazing systems. Where farm plans were not taken up individual erosion control projects were undertaken. In the North Island the greatest need was to encourage the use of space planted trees in hill country. All these activities involved working with the farmers, either individually or in groups, as part of wider scheme activities. Over the years Land Management Officers (LMOs) have broadened their activities into wider aspects of sustainable development including alternative land uses, nutrient management and biodiversity protection, but the core methods of achieving their goal of reducing erosion remain the same. These methods include a broad professional knowledge of their physical environment, erosion control techniques and farming systems and, most importantly, the ability to relate to individual farmers. The following sections endeavour to illustrate the practical approaches used by LMOs that make their work successful.

THE USE OF THE TERMS ACCELERATED AND NATURAL EROSION

15. Based on 45 years of experience in the field it is my opinion that the distinction between natural and accelerated erosion is meaningless. It is mostly impossible to clearly differentiate between the two in the field and the distinction is not even considered when planning to control erosion through soil conservation practices. The term “natural” is accepted as “without human influence”. The time frame of no ‘human influence’ ranges from more than 500 years to less than 100 years depending on one’s viewpoint. The influence of animals on current native forest vegetation adds another dimension to the difficulty of finding un-modified areas for base line data collection. Since deforestation the hill country soils are adjusting as they once were forest soils and now they are becoming predominantly pastoral soils. Consequently, many of the factors associated with their continued development have changed e.g, the material from which the soil organic matter was formed, the soil biota (animals), exposure to the elements and the types and depths of root masses helping to hold the soils in place. These changes are occurring at different rates depending on soil type, rock type, slope, aspect, vegetation etc and not enough is known about these processes to fully understand them. But one of the accepted results of these changes is a lowering of the soil’s critical limits of stability. In practical terms we don’t need to fully understand these processes as we are working with present day situations. I believe it is a red herring to suggest we need to. In summary, we cannot differentiate between what is natural and what is accelerated without a huge amount of costly and time consuming research.

16. The first edition of the Land Use Capability Survey Handbook (MWD 1969), the bible for soil conservation land use capability mappers, allocated only one paragraph to ‘natural’ erosion saying … ’*this is part of the normal cycle of the weathering of landscapes. “n” following any of the accelerated erosion symbols indicates a high rate of geological erosion, and the sum effect of both types should be recorded.’*

17. In the 3rd Edition of the Land Use Capability Survey Handbook (2009) it was not considered worthwhile to differentiate between the two. Instead, the concentration is on mapping the present erosion, and assessing the potential for increased erosion as this is what LMOs are charged with managing. The LMOs' job is advise on repairing erosion, returning erosion scars to a vegetated state, to reducing the risk of further erosion, as well as advising on sustainable development issues which minimise erosion risk. For this reason, LMOs map present erosion and its severity and assess the potential for erosion as part of the inventory mapping for Whole Farm Business Plans (WFBP).

18. The inclusion of coastal dune erosion adds a further complexity. I believe the extent of dune erosion has been reduced from its pre-European levels by current management systems. Concentrated forestry programmes behind the foredunes and marram grass planting of breakouts of dunes have dramatically reduced the rate of sand movement in European times. It is the heightened perception of the moving sand caused by urban development into foredune sites without proper management systems being in place that creates the problem. In the rural areas, with current management practices using shelter belts and minimum tillage systems, it would often be a case of the 'natural' erosion rates being higher than the 'accelerated' rates.

    I recommend the terms '*accelerated*' and '*natural*' not be used and that they be replaced by the term '*erosion*'.

HOW THE LAND USE CAPABILITY CLASSIFICATION ADDRESSES THE EROSION FACTOR

19. In my opinion the Land Use Capability (LUC) Classification system used in the Manawatu-Wanganui Regional Council's farm plans is ideal as a base for 'Objectives' in the plan, but it has not been used anywhere near its potential. To address this I have provided a short summary of the classification to assist the Court in more fully understanding the system.

20. Land use capability is the systematic arrangement of different types of land according to those properties that determine its capacity for long term, sustained production. It is a very powerful planning tool which has been the cornerstone of soil conservation planning and soil and water farm plans in New Zealand since 1952. During the time of NWASCO, a land use capability assessment was a prior requirement for central government erosion control grants and every soil conservator in the country was trained in its use. Since 1988, when the Regional Councils were formed, it has been up to individual Councils to continue with its use. The Manawatu-Wanganui Regional Council has been one of the supporters of the system, continuing to use it as the basis of its Whole Farm Business Plans. I understand all the Council's Land Management Officers (LMOs) are trained in its use. Many have attended LUC training courses with which I have been involved.

21. In the 1970s, NWASCO undertook the New Zealand Land Resource Inventory (NZLRI) which provided national coverage and standards at 1:63360 scale. This provided regional Land Use Capability classifications. The Manawatu-Wanganui Regional Council area was covered within three of these regional classifications.

22. There are two components to the LUC assessment system:

- A Land Resource Inventory. This comprises five physical factors considered to be critical for long term, sustained land use. These are mapped simultaneously using a homogeneous map unit method. The five factors are: rock type, soil, slope group, erosion type and degree and vegetation cover.

- A Land Use Capability. The physical factors, together with climate and the effects of past land use, allow an assessment of each land management unit's long term capability for sustained production to be made by the mapper. This is the Land Use Capability assessment. The LUC classification comprises eight classes, four subclasses and land use capability units. LUC units group together land

management map units with similar management and soil conservation requirements and similar crops and yields.

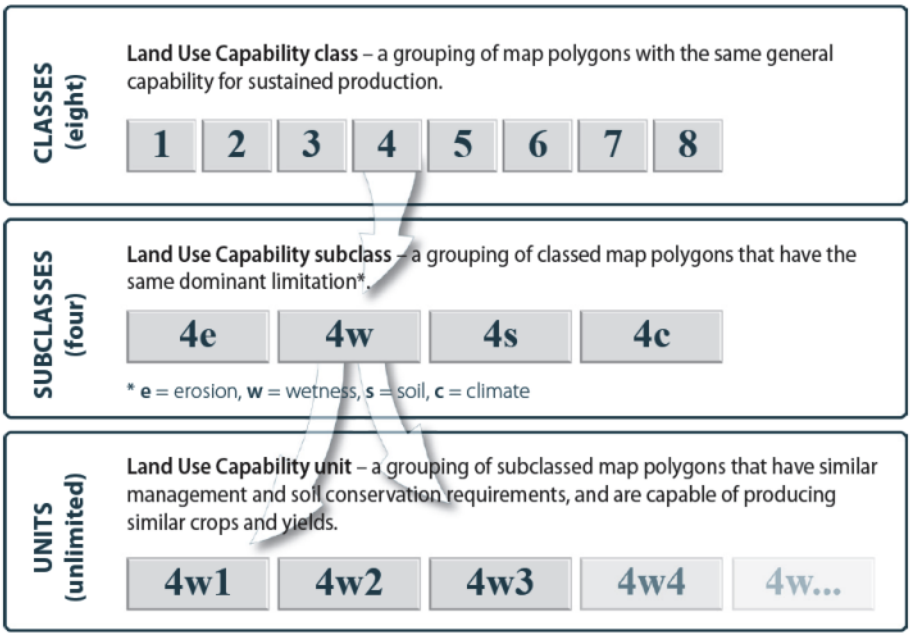

Fig. 1: Components of the Land Use Capability Classification (From Lynn et al., 2009)

23. From the LUC, or a combination of LUC and Inventory, a range of recommendations can be made. These can form the basis for the five year work programme for the farm plan.

24. The Land Resource Inventory:

- Rock type. A classification has been developed (Lynn et al., 1991) specifically for soil conservation planning. It groups rocks which have similar erosion susceptibilities and characteristics, directly influence surface morphology and, therefore, land use, can be recognised and mapped by LMOs, and can be readily understood by planners and land managers;

- Soils. Available soil information is patchy, requiring the mapper to interpret available data in the field to obtain quality information;

- Slope. Standard slope groups are used. These identify the dominant slope within each map unit. Dominant slopes are used (in contrast to an individual slope) as, in most hill country, slopes are hugely variable over a small area;

- Erosion. Up to three erosion types are recorded together with their assessed severity (ranked on a 0-5 scale). See Fig. 3 for the classification. The erosion classification is described more fully in Eyles (1985). (In the Manawatu-Wanganui region all of these types occur.)

  Only present erosion is recorded. It is considered 'present' until the exposed areas are covered by vegetation or, as with slow moving earthflow, until evidence of continuing movement is no longer identifiable.

  Severity is a professional assessment based on difficulty of repair, from 0 (negligible), 1 (slight), 2 (moderate), 3 (severe), 4 (very severe) to 5 (extreme). Potential erosion is also assessed, but at the LUC unit level. This uses the same six part system. The assessment assumes a grassland cover with average management and with no soil conservation measures applied. Again, this is a professional assessment.

- Vegetation. Management based vegetation groups are recorded using a 51 part classification, with up to four allowed in any map unit.

25. Land use capability assessment

- Based on the inventory, together with a knowledge of climate and the effects of past land use, the suitability for long term and sustained use (LUC) is assessed for each map unit;
- The LUC classification follows national standards as set in the Land Use Capability Survey Handbook (Lynn et al., 2009). These standards are regionally

defined in regional land use capability extended legends and are described in regional classification bulletins. The Manawatu- Wanganui region is covered by parts of three NZLRI Regional LUC classifications. The most extensive is The Land Use Capability Classification of the Taranaki-Manawatu region. This is described and defined in Fletcher (1987) and the Land Use Legend (Fletcher,

Slope Classification

Slope Group	Slope angle (degrees)	Description	Typical examples
A	0–3°	Flat to gently undulating	Flats, terraces
B	4–7 °	Undulating	Terraces, fans
C	8–15 °	Rolling	Downlands, fans
D	16–20 °	Strongly rolling	Downlands, hill country
E	21–25 °	Moderately steep	Hill country
F	26–35 °	Steep	Hill country and steeplands
G	>35 °	Very steep	Steeplands, cliffs

Additional symbols that can be used

+	Compound slopes. This is used where more than one major slope group occurs in a unit. For example, D+E slopes means that slopes are mainly strongly rolling but the unit contains a significant area of land with moderately steep slopes.
/	Slopes which are borderline between two slope groupings are recorded in the form D/E, i.e. most slopes are 20–21 degrees.
‘	A dash to the top right of a slope symbol indicates the slopes are dissected. For example A′ indicates that the land is flat to gently undulating but is dissected by narrow entrenched gullies or drainage lines.
$^{+}$ or $^{-}$	Superscripts $^{+}$ and $^{-}$ are optional symbols to indicate to which end of the slope group the slope actually lies. For example, the symbol F^{-} indicates that the measured slope is closer to 26°, while F^{+} would indicate that the slope is closer to 35°.

Fig 2: Slope groupings (from Lynn et al., 2009).

Erosion Classification

Category	Erosion types	Symbol	Optional prefixes (examples)
1. Surface erosion	Sheet	**Sh**	
	Wind	**W**	
	Scree	**Sc**	
2. Mass movement	Soil slip	**Ss**	s = shallow, d = deep, r = riparian
	Earthflow	**Ef**	s = shallow, d = deep, r = riparian
	Slump	**Su**	s = shallow, d = deep, r = riparian
	Rock fall	**Rf**	
	Debris avalanche	**Da**	
	Debris flow	**Df**	
3. Fluvial erosion	Rill	**R**	
	Gully	**G**	s = shallow, d = deep
	Tunnel gully	**T**	
	Streambank	**Sb**	
4. Deposition	Deposition	**D**	

Fig 3: Erosion types and symbols (from Lynn et al., 2009).

1981) which accompanied the 1:63,360 scale resource inventory maps covering the whole region. I understand these three regional classifications have been combined into one covering the whole region. I have confidence its use will make understanding of the LUC system much simpler for landowners when they wish to identify what types of land their farm comprises. The maps have been converted to a GIS data base at 1:50,000 scale. At the farm planning scale the regional classification is still appropriate but, where necessary, the regional LUC units may be subdivided into (a), (b) etc., depending on aspect or slope length.

26. Figure 4 illustrates the increasing limitations and decreasing versatility of LUC Classes from 1 to 8.

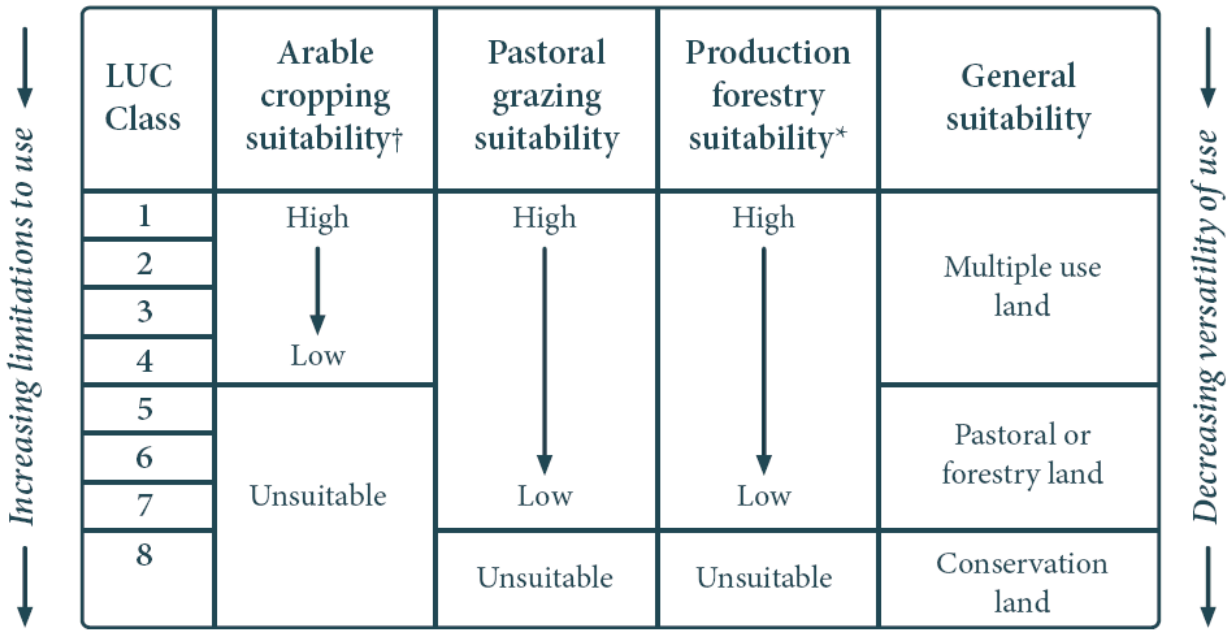

Fig. 4: The increasing limitations and decreasing versatility of use from LUC Class 1 to LUC Class 8. (From Lynn et al., 2009)

27. Depending on the scale, recommended land uses can be developed based on the LUC assessments. An example can be taken from the Pohangina area. On the Pohangina sands LUC unit 8e2 comprises large gullies with unstable sides (this is best suited for retirement), LUC unit 7e16 comprises steep slopes on extremely weak sands and has a severe potential for slip erosion (this is best suited for forestry but could remain in pasture with intensive space planting of deciduous trees), and LUC unit 6e14 is the easier hill country where space planted trees and effective pasture management will control erosion (this is suited for pastoral use with space planted erosion control trees on erosion prone sites).

28. In summary, the LUC system identifies, for each map unit, both the present erosion and the potential for erosion. The potential is assessed on the basis of difficulty of repair when in pasture with no soil conservation measures applied. A typical farm

plan may have 50 to100 or more map units and 5-15 LUC units. From this, recommended land use maps and annual work programmes can be developed.

29. Both present erosion and the potential for erosion are addressed in this mapping procedure, the management options to minimise the risk are identified and can be implemented.

30. As well as providing a detailed resource base upon which to plan individual farm development, these plans, if they covered all the highly erodible hill country, would provide a comprehensive data base for regional planning.

31. It is worth noting that Dymond and Shepherd (2006) define highly erodible land as "*land with potential for severe erosion if it does not have woody vegetation*." The land under woody vegetation is as erodible as similar land under pasture as it is the same land. The only difference is that the tree cover raises the trigger point above which erosion occurs. Post storm erosion studies confirm that native forest is the best soil conservation cover, followed by closed canopy exotic forest, then scrub, with pasture being the least effective. When the land with a forest cover does erode the associated debris causes more severe downstream damage than pasture. I believe it is dangerous to define a degree of erodibility solely on vegetation cover as vegetation changes – what is the status when that cover is degraded, say, by deer, goat damage or fire? The inclusion of a map which identifies land at risk of erosion should also include land which is considered at risk of erosion but which is covered by vegetation.

32. Dymond and Shepherd, in their s42a evidence (appendix 2 of Dr Dymonds s42a report), list in table 1, the LUC units they believe should be in the Erosion Management Areas. I have checked these LUC units and agree that they are appropriate and agree that, collectively, they comprise the erosion management areas.

33. What is essentially needed is a system where the landowner can enter the Council's web site and access the Erosion Management Areas map and be able to enlarge this to 1:50,000 scale (at which scale it was inputted to GIS) . Where farm plans have

been prepared the Council could enable these to be accessed to their compilation scale (approx 1:10,000 scale). This data can be overlaid by the property boundary data set enabling farmers to view their own properties. In my opinion this system would be the best way to give accurate access to the best information, and would provide a mechanism by which individuals could determine whether or not their activities fall within an erosion management area and hence regulatory regime. I note there could an issue of confidentiality with the farm plan data sets. If this is the case, it could be overcome by requiring a different level of authorisation to access specific levels of data. If a farmer does not have access to a GIS system they could visit the local Regional Council office or local library where the Council could establish access points. This approach would provide easier access than having to visit Council offices to look at maps.

34. There is an argument that each farmer needs access to data in map form. I believe this is not economically or practically feasible.

CRITICAL SLOPE CRITERIA

35. The proposed One Plan uses the slope angle of 28^0 to define the critical slope angle for an increased risk of erosion. While this figure is contained in a report by Blaschke et al (1992) and DeRose et al (1993) on slope limitations to sustainable land use in hill country prone to landslide erosion, I do not think this means it should be applied. The 28 degree slope is based on **one** study in the eastern Taranaki hill Country. I am concerned at its application across the entire Manawatu Wanganui Regional Council area as it is derived from landslide- productivity studies undertaken at Makahu in the Taranaki sandstone hill country in the 1980s. DeRose's review (1995) which refers to this earlier work goes on to state that "*while these results have been particularly useful in helping to define land use sustainability on hard Tertiary sandstone lithologies they cannot be applied without qualification in other regions*" (De Rose et al, 1995, page 2). DeRoses et al review (1995) indicated the limiting slope for landslide occurrence for most hill country areas in the North Island is between 18 and 24 degrees which

indicates a much lower slope angle than 28 degrees is appropriate. In my opinion the difference is due to the effect of different rock types which have differing trigger slopes for landslide erosion.

36. The Manawatu Wanganui region has many different rock types and these, together with the effects of shatter zones, means there is no specific critical slope angle above which higher intensities and severities of erosion occur. For instance, earthflow and gully erosion, which are also major sources of sediment generation, occur extensively in the region. Earthflow erosion can occur on a wide range of slopes depending on the rock type. For example, it occurs in jointed mudstones on slopes over 20^0 which occur in a band from south of Hunterville across to Wanganui, and on slopes as low as 15^0 along the coast south of Akitio in mudstones with high levels of montmorillonite. Gully erosion has many forms; on the uncemented ignimbrites (pumice) in the upper Wanganui catchment vertically sided gullies can form across flat river terraces (as low as 1 degree slope), while in the Pohangina sands very deep, vertically sided gullies cut up near flat valley bottoms (again as low as 1 degree slopes) and into steep hill slopes (slopes are variable, ranging from around 21 degrees to >35 degrees slope). On mudstones, gullies are less steep and follow the contour of the hill slopes (slope range from 8 degrees up), with sides slipping and flowing in to provide off-site material. Valley bottoms scour out this debris during storms.

37. The 28^0 value is also incompatible with the slope groupings used for WFPB programmes. The WFPB system uses the nationally consistent slope groupings (see Fig 2). These groupings recognise that, in the field, a range of slopes generally occur within any one management unit and it is more effective to map groups of slopes than try to identify an individual slope. Only the scientist has the time to study individual slopes, the practitioner needs to map management areas and the only way this can be done effectively is to use slope groups.

38. Dymond provided a paper by DeRose summarising Slope Limitations to Sustainable Land Use in Hill Country Prone to Landslide Erosion. He stated "*with a threshold slope above which 95% of landslides occur, most landslides occur on slopes above 20 to* 33^0

for most hill country areas." My experience is that on the same rock type the steeper the slope the higher the chances are of slips, but slips on steep slopes generally produce less volume of sediment than slips on less steep slopes as the regolith is shallower.

39. Dr McConchie, in his evidence at the Council hearing, stated that erosion leads to greater stability on steepland environments. In my experience this is not the case as our soft rock environments weather so rapidly that slips occur on previously slipped sites within about 50 years. It may work in hard rock environments but the result would be minimal pastoral production on hard rock surfaces.

40. In my opinion, the proposed One Plan needs to base its critical slope angle on the LUC unit slope groupings, not on individual slope degrees. This is because the LUC units take into account those physical factors that predispose an area to erosion. The LUC Class 7e units, for instance, are defined as such because of the serious risk of erosion. An example of this can be seen in Table 1 of Dymond and Shepherd's paper "*Highly Erodible Land In The Manawatu-Wanganui Region*" (2006) which groups the LUC units comprising highly erodible hill country. I have confidence that the approach provides a useable grouping.

41. To reiterate I believer that appropriate land management approaches should be based on the identification of land at an elevated risk of erosion. Farm scale LUC mapping as undertaken in the preparation of a WFBP provides sufficient data to access the impacts of an activity on that land, where this does not exist, the NZLRI, LUC unit data should be used.

42. However, if a slope angle is to be used, I recommend that it be 20^0 (which is the D E slope group boundary) based on DeRose's review, rather than the much higher 28^0 in the proposed One Plan, as it takes a more precautionary approach. 28^0 will miss significant erodible areas. This slope will obviate the need to re map the region identifying the 28^0 line as the 20^0 limit is already mapped in the NZLRI sheets and in each WFBP. Dymond and Shepherd's table 1 (from appendix 2 of Dr Dymonds s42a

report) indicates the slope threshold above which significant erosion occurs. These slope thresholds range from 22 degrees to 32 degrees depending on the rock type. Twenty degrees, therefore is a good precautionary figure.

43. My preferred option for appropriate slope standards is that the map of erosion management areas be reinstated. For properties within these areas with a WFBP, actions could be permitted conditional on their being part of the approved work programme. This is because an assessment of effects will have been undertaken by the LMO, and appropriate remedial actions will be included in the works programme. For properties without a WFBP, the critical slope angle should be set at 20^0. Above this, any consenting activity would require the visit of a LMO who would assess the LUC of the area of concern. If it was a LUC unit identified as critical in the erosion management area (Schedule A or insertion of another appropriate map identifying land at an elevated risk of erosion), it would need to be processed appropriately. If not, the work could be approved by the LMO on site.

THE IMPORTANCE OF LAND USE CAPABILITY MAPPING AT THE FARM SCALE, AS A FIRST STEP IN WORKING TOWARDS SUSTAINABLE LAND MANAGEMENT FOR PASTORAL AGRICULTURE

44. The development of soil conservation in New Zealand has shown that farm plans are an essential tool for the sustainable development of properties and especially hill country properties.

45. Over the years these plans have evolved from being purely erosion control plans to being whole farm development plans. (Until the 1970s flood control and erosion control were the overriding national concerns.) In the 1960s soil conservators were not allowed to include pastoral development recommendations in the plans, as that was the Department of Agriculture extension officers' job. It took some time for soil conservators to be able to work round these issues. With the introduction of the regional councils these issues disappeared, allowing sustainable development to

become the primary drivers. Thus, while the inventory and land use capability components of farm plans (plans have had different names depending on the authority and their use) remained standard, the recommendations and interpretations were able to be widened to reflect the policies of the individual councils.

46. The process of preparing a physical resource inventory and assessing the LUC provides a detailed understanding of the whole property. Adding an economic business analysis provides a further dimension. Together, the information enables the farmer to identify:

- areas where further sustainable development can occur
- areas where land use should change
- areas needing retirement from grazing
- areas needing particular uses to achieve specific goals such as reduced nutrient outputs or reduced risk of stream bank erosion
- areas of biodiversity value
- locations where water quality improvements can occur.

47. In the Manawatu-Wanganui Regional Council's hill country areas the preparation of 100 Whole Farm Business Plans annually for five years will result in the most comprehensive and detailed physical resource data set in New Zealand. I understand that currently the Council has completed 369 Whole Farm Plans covering 280,441 ha (28% of the hill country farmland.) This will be of great value for future planning of sustainable land use intensification in the hill country.

48. The WFBP provides the ideal platform for interaction between council staff and farmers. For the plan to be successful the LMO needs to form a relationship with the farmer, (rural people work best on trust). Once this relationship is developed they work together to create a workable five year management plan which is acceptable to both parties. The LMO then visits regularly and so is able monitor progress and deal with issues as they arise. This synergy leads to quality practices. However, the LMO does represent the Council. This relationship building is critical, as the easy part is the

preparation of the plan. The hard part is completing the work programmes in a world of ever changing economics and environmental issues.

49. There has been concern expressed by some farmers that a WFBP would put them out of business as they would have to retire too much land. The WFBP provides an independent assessment of the sustainability of each part of a property. It identifies areas where development can be increased (e.g., LUC Classes 1-5), areas where development needs to be considered carefully and may need a change in land use e.g., LUC Class 6e where development may need space planted erosion control trees or LUC Class 7e units where a change to a commercial timber plantation may be preferable, and areas which need to be retired (e.g., LUC Class 8 units). These will vary depending on the individual farm. Occasionally, a plan will indicate to a farmer that the property has too many limitations to be economically viable, but that is information that allows the farmer to be pro-active in making long term decisions such as selling or adding to the block. More frequently, it identifies where development can be intensified, creating a more economic unit.

50. A WFBP allows the farmer to develop a resilient property. In large areas of the region there is a historical resistance to trees on hill country properties. The term 'pastoral deserts' comes to mind. These properties generally came from forest to pasture. The history of our Tertiary hill country throughout New Zealand is that, without some form of tree cover, it slips, slides, flows and gullies, depending on the particular rock type and exposure to rainfall dumps. From the early soil conservation days there has been recognition that trees are needed on these lands. There are two options. One is a closed canopy tree cover such as *Pinus radiata* which excludes grazing and the other is the use of space planted deciduous hardwoods. Poles planted at about 18 m spacings on potentially erodible land allow the continued grazing of hill country and even its continued intensification in many areas. Earthflows require different planting densities to stabilise them, as do gully prone areas. These measures reduce the risk of erosion by raising the trigger point at which it will occur. This, in turn, reduces sediment generation and, therefore, improves water quality, surely a win win situation.

The WFBP can also be used to identify where riparian retirement is best applied and where wetlands can be created to provide nutrient stripping.

51. All these issues are addressed in a WFBP making these a key tool in any progressive regional plan, and assisting the farmer in developing a resilient property.

52. The alternative to the whole farm plan approach is to look at single issues. In this approach a programme will be initiated to control a gully or an earthflow or a badly slipping paddock. Standard soil conservation techniques are used in this process BUT there is no overall planning undertaken for the whole farm. The LMO moves from one issue to another with no overall focus. It is 'fix up' rather than prevention.

THE IMPORTANCE OF RIPARIAN MANAGEMENT IN ACHIEVING BOTH ON SITE AND OFF SITES BENEFITS

53. I support the comments made by Mr Ngapo re the importance of riparian management. The retention of riparian vegetation, especially willow vegetation (willows have a root mat able to protect the surface from scour and when lopped, branches cover the bank and these root further stabilising the surface) is essential in stabilising stream bank erosion in high energy systems. Stream bank erosion is a major source of sediment in many of the high sediment generating catchments. Sediment is deposited along the banks during major floods and is progressively removed during smaller floods. Low terraces have their edges cut away in a natural process which humans endeavour to stop because the terraces often have high production.

54. Riparian vegetation especially native vegetation, together with grasses and other low vegetation also provide a positive nutrient filtering system.

SPECIFIC COMMENTS ON RULE RELATING TO VEGETATION CLEARANCE AND CULTIVATION

Cultivation in Hill Country

55. Cultivation in Hill country is generally used for either of two purposes; for pasture renewal including a means of smoothing a rough natural surface, or to provide a seed bed for a commercial crop. In the Manawatu-Wanganui region the soils vary greatly in their surface erosion capability when cultivated. Pumice (uncemented ignimbrite) will sheet and rill on slopes as low as 1^0 and loess soils on slopes as low as 3^0. Thus it is difficult to use a single slope to provide a limit. I believe the LUC unit is the correct unit to use to provide limits. LUC Classes 5, 6, and 7 are usually only cultivated for pasture renewal, generally once in 5 to10 years, often with a fodder crop as part of the process. Rainfall on cultivated surfaces on hill country can result in runoff, first in the form of sheet flow which then concentrates into channelised flow. Sheet flow removes soil particles in the process of sheet erosion and channelised flow results in rill erosion leading to gully erosion. Channelised flow can move through riparian strips irrespective of the cover until the velocity reduces to the extent the water can settle, whereas sheet flow can be held up by a riparian strip allowing sediment to settle.

56. In my opinion, the best approach is a precautionary one. Cultivation on hill country properties which have an operational WFBP could be a permitted activity, as long as appropriate setback distances are applied (as discussed in the evidence of Associate Professor Death) as the option available to protect a waterway when undertaking pasture renewal through cultivation. This will have been discussed with the LMO and the appropriate option agreed. For properties without a WFBP, LUC Classes 5, 6 and 7 or slopes greater than 20^0 would be regulated through the consenting process. It would require the visit of a LMO to assess the LUC (or the slope angle) of the area, along with the appropriateness of the activity and potential effects.

57. On croppable land (i.e., LUC Classes 1 to 4 inclusive or below (20^0) appropriate setback distances should apply (as discussed in the evidence of Associate Professor Death). In addition, ephemeral waterways (drainage lines) in cultivatable paddocks should not be cultivated.

Vegetation Clearance in Hill Country

58. The Hill Country Erosion Management Areas are best protected by native forest. Removal of this vegetation, to be replaced by pasture, is likely to lead to increased risk of erosion. It is, therefore, important for the proposed One Plan to ensure any clearance of this cover is carefully managed and only occurs where it is safe to do so. While it is likely little mature forest will be cleared, there needs to be a very clear case made before any is undertaken.

59. Native regeneration, which includes scrub (predominantly manuka/kanuka), has a higher protection value than pasture, but it needs to be encouraged to develop to mature forest. Its value increases as the vegetation matures. Historically, scrub was cut about each seven years, presumably as this was when it reached a sufficient size (generally 1-2 m high) that it could be cut and it was reducing the carrying capacity of the pastured slopes. Today, it is either cut or sprayed, usually as economics allow, as most occurs on the more marginal hill country.

60. Any proposed clearance of mature forest, on land identified as at risk of erosion should be assessed by a LMO to allow an assessment of the appropriateness and likely effects of the activity.

CONCLUSIONS

- Based on 45 years of experience in the field it is my opinion that the distinction between natural and accelerated erosion is meaningless. I recommend the terms '*accelerated*' and '*natural*' not be used and that they be replaced by the term '*erosion*'.

- Land use capability is the systematic arrangement of different types of land according to those properties that determine its capacity for long term, sustained

production. It is a very powerful planning tool which is the cornerstone of soil conservation planning.

- I recommend the reinstatement of an appropriate map/ access to GIS layers within the council website to illustrate LUC classes and units at an elevated risk of erosion in the region, including those which are currently under vegetation cover. The appropriate LUC classes and units should be referenced within and provide the basis for the regulatory framework. Management/ regulatory approaches established in the Plan should be targeted at the appropriate land.

- The proposed One Plan uses the slope angle of 28^0 to define the critical slope angle for an increased risk of erosion. This threshold is inappropriate. My preferred option for appropriate slope standards is that the map of erosion management areas be reinstated. However, if a single slope angle is to be used, I recommend that it be 20^0.

- The establishment of WFBP is the cornerstone in any progressive regional plan. The WFBP assists the farmer in developing a resilient property.

- The alternative to the whole farm plan approach is to look at single issues, and regulate accordingly.

- Land disturbance, cultivation, and vegetation clearance can have adverse effects on the environment.

- Cultivation on hill country properties which is undertaken in accordance with an operational WFBP could be a permitted activity, as long as appropriate setback distances are applied, as the appropriateness of the activity would have been assessed by LMO. For properties without a WFBP, LUC Classes 5, 6 and 7 or slopes greater than 20^0, I would recommend regulated through the consenting process.

- The Hill Country Erosion Management Areas are best protected by native forest. Removal of this vegetation, to be replaced by pasture, is likely to lead to increased risk of erosion. Any proposed clearance of mature forest, on land identified as at risk of erosion should be assessed by a LMO to allow an assessment of the appropriateness and likely effects of the activity under a consent or through WFBP.

- The retention of riparian vegetation, especially willow vegetation is essential in stabilising stream bank erosion in high energy systems. Stream bank erosion is a major source of sediment in many of the high sediment generating catchments. Riparian vegetation especially native vegetation, together with grasses and other low vegetation also provide a positive nutrient filtering system.

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REFERENCES

Blaschke, P.M., Trustrum, N.A., & De Rose, R.C.1992. Ecosystem processes and sustainable land use in New Zealand steeplands. *Agriculture,Ecosystems and Environment 41:* 153-178.

DeRose, R.C., Trustrum, N.A., & Blaschke, P.M. 1993. Post deforestation soil loss from sttepland hillslope in Taranaki, New Zealand. *Earth Surface Processes and Landforms 18*: 131- 144.

DeRose, R. 1995. Slope limitations to sustainable land use in hill country prone to landslide erosion. Unpublished Report, Landcare Research, Palmerston North, New Zealand.

Dymond, J., & Shepherd, J. 2006. Highly erodible land in the Manawatu. Landcare Research Contract Report: 0607/027

Eyles, G. O., 1985. The New Zealand Land Resource Inventory Erosion Classification. Water and Soil Miscellaneous Publication No 85.

Hicks, D. L., Fletcher J. R., Eyles, G. O., McPhail, C. R., & Watson, M. 1993. Erosion Of Hill Country in the Manawatu-Wanganui Region 1992. Impacts and Options for Sustainable Land Use. Landcare Research Contract Report: L C 9394/51.

Fletcher, J. R. 1987. Land Use Capability Classification of the Taranaki-Manawatu Region: a bulletin to accompany the New Zealand Land Resource Inventory Worksheets. Water and Soil Miscellaneous Publication No 110.

Lynn, I. H., Crippen, T. F. 1991. Rock Type Classification For The New Zealand Land Inventory. DSIR. Land Resources Scientific Report No 10. Lower Hutt, New Zealand.

Lynn, I., Manderson, A., Page, M., Harmsworth, G., Eyles, G., Douglas, G., Mackay, A., & Newsome, P. 2009. Land Use Capability Survey Handbook- a New Zealand handbook for the classification of land (3rd ed.). AgResearch Lincoln.

MWD 1971. Land Use Capability Survey Handbook – a New Zealand handbook for the classification of land. Ministry of Works, Wellington, New Zealand.