Cadmium Levels from Fertiliser in Soil and Food: The Adequacy of New Zealand's Law and Policy

Catherine Dearsley*

This article addresses the question of whether New Zealand's law and policy is adequate to deal with the problem of cadmium in our soil, food and water which occurs as a result of phosphate fertiliser use on production land. It finds that the Resource Management Act 1991 was drafted with the foresight to manage these issues making provision for ministers and local government to more strongly regulate contaminants, yet they are not consistently or adequately doing so. There is much promise in an ambitious National Cadmium Management Strategy launched in 2011, which is designed to provide a national approach for managing cadmium in New Zealand agriculture. Until this produces tangible results, we remain in the situation where shortfalls in the contaminated land regime and food safety result in inconsistent national regulation which has little or no scrutiny or enforcement. The point at which legal responses are triggered is only once the damage is done; the equivalent of the ambulance at the bottom of the cliff. There are three main significant issues flowing from cadmium soil contamination.[1] Firstly, accumulating cadmium in soils until it reaches the soil guideline for its intended use results in the loss of versatile soil capacity. Secondly, cadmium levels in food are regulated and non-

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1 Nick Kim *Cadmium Accumulation in Waikato Soils* (Environment Waikato Technical Report 2005/51) at iv.

compliance with the food standards because of soil contamination can also lead to loss of this soil capacity. Thirdly, soil contamination has the potential to result in international market restrictions for our produce and harm the reputation we strongly trade and rely upon. The issues are complex and we require greater understanding of the processes and pathways in which cadmium acts in our bodies, our food, our plants, our soils and waterways. This article finds that alongside the voluntary initiatives promoted under the national strategy there would be benefits from regulation to ensure appropriate testing to identify land with higher cadmium levels, and the cadmium status of higher-risk food strains, as well as stipulating new lower maximum levels of cadmium in fertiliser. The management of these factors is seen as critical to achieving sustainable long-term farming in New Zealand.

1. INTRODUCTION

You're going to reap just what you sow.

— Lou Reed[2]

Not all soils are created equal. Our productive land is our most versatile land, a precious resource able to sustain the widest range of human activities including commercial food production. It is this land that underpins our economy and food security. The levels of the heavy metal cadmium have been building up slowly in our soils as an unintended result of using phosphate fertiliser over the past 70 years.[3] The accumulation of cadmium in topsoil at present rates is unsustainable as it eventually results in contaminated land and a loss of the soil resource.[4] The presence of cadmium in phosphate-based fertiliser is recognised worldwide as a "potential environmental and dietary issue".[5] Cadmium is considered a carcinogen which enters the human food chain primarily from vegetable crops, and just as in soil, it accumulates slowly in the body over decades so a person's dietary exposure is measured over a lifetime. Healthy plants can accumulate

2 From lyrics of "Perfect Day" from *Transformer* album (RCA Records, 1972).

3 MD Taylor "Accumulation of cadmium derived from fertilisers in New Zealand soils" (1997) 208 Science of the Total Environment 123 at 125.

4 Matthew Taylor and others *Soil Maps of Cadmium in New Zealand* (Landcare Research, June 2007) at 9.

5 Jo Cavanagh *Status of cadmium in New Zealand soils* (Landcare Research, March 2014).

enough cadmium to harm humans over 50 years of chronic dietary exposure: "therefore we must limit cadmium in soils and soil amendments".[6]

Unrestricted accumulation of cadmium in prime productive soils is a situation that presents serious potential long-term risks to our economy; international reputation; human and environmental health; and food security. It may well also cause restricted future land usage, falling land values and increased development expenses. "Policymakers and regulatory agencies have been slow to appreciate the largely irreversible nature of soil resource depletion that is occurring."[7] Potential future costs have not been factored into the current contaminated land regime which insufficiently deals with the act of contaminating production land, or the policies that strongly incentivise land-use transition to more intensive farming practices.

New Zealanders are highly dependent on the natural capital of productive soils to sustain our wealth-generating capabilities.[8] The Parliamentary Commissioner for the Environment has highlighted the importance of sustainable farming practices and our reliance on our productive soils:[9]

> It is a precious non-renewable (in human time scales) limited resource … After taking thousands of years for fertile soil to form, agricultural practices can undermine this most fragile yet fundamental form of natural capital in a short time via erosion, compaction, loss of organic matter, contamination and salinisation.

The National Cadmium Management Strategy was instigated by the Cadmium Working Group in 2011 to tackle the problem of cadmium accumulation in agricultural soils. The group is comprised of representatives from central and local government and the fertiliser and agricultural industries. The Strategy is a comprehensive ambitious programme that holds promise of careful future management. The Strategy acknowledges however that we are currently on a firm path to continuing to accumulate this heavy metal in our soil due to our dependence on phosphate fertiliser. Central to the Strategy is a Tiered Fertiliser Management System designed to impose more stringent fertiliser management practices as soil concentrations of cadmium increase.[10] This

6 Rufus L Chaney "Chapter Two — Food Safety Issues for Mineral and Organic Fertilizers" (2012) 117 Advances in Agronomy 51 at 62.

7 Kim, above n 1, at 43.

8 Parliamentary Commissioner for the Environment *Growing for good: Intensive farming, sustainability and New Zealand's environment* (Parliamentary Commissioner for the Environment, 2004) at 5.

9 At 25–26.

10 Cadmium Working Group *Cadmium and New Zealand agriculture and horticulture: a strategy for long term risk management* (Ministry of Agriculture and Forestry Technical Paper No: 2011/02, February 2011) at 13.

relies on the voluntary commitment of farmers, many of whom are unaware of any issue with cadmium in their soil. Whether this strategy can deliver more sustainable farming for New Zealand is not yet clear. It requires voluntary stakeholder buy-in, support, and the resourcing of research and development strategies.

Yet lowering levels of cadmium in fertiliser would go a long way to prevent further accumulation (see part 2 below) and is not yet addressed by the Strategy. Australia has greatly reduced levels of cadmium in its fertilisers (see part 7 below). This example shows that manufacturers do not have to be coerced into compliance with regulation, but it is recommended in the absence of them taking their own initiative.

2. CADMIUM: THE ISSUES

2.1 The Significance of Cadmium in Soils

Cadmium is a heavy metal normally found in the environment in trace quantities. Above relatively low levels it is considered toxic to animals and plants, and is identified as a human carcinogen.[11] Phosphate fertilisers are the main source of cadmium found in New Zealand soils.[12] Phosphate is an invaluable soil additive allowing us to maintain the productivity of our farming, especially as New Zealand's soils are naturally low in phosphorus.[13] Unfortunately cadmium is usually found in higher than average concentrations in the phosphate rock that is used to make fertiliser.[14] After fertiliser is applied to land, cadmium predominantly remains in the topsoil,[15] where it will accumulate with repeat applications until the levels eventually reach the soil contamination guidelines or exceed those considered safe for food production.

Cadmium is a key soil contaminant in New Zealand because its levels in our food are closer to the provisional tolerable weekly intake than any other monitored contaminants.[16] There are other impurities of concern also

11 Kurt Straif and others "A review of human carcinogens Part C: metals, arsenic, dusts, and fibres" (2009) 10 Lancet Oncology 453 at 454.

12 P Loganathan and others "Fertiliser contaminants in New Zealand grazed pasture with special reference to cadmium and fluorine: a review" (2003) 41 Australian Journal of Soil Research 501 at 504.

13 Allan Gillingham "Soils and regional land use: Overview" (2012) Te Ara — the Encyclopedia of New Zealand <www.teara.govt.nz>.

14 Cadmium Working Group *Report One: Cadmium in New Zealand Agriculture* (Ministry of Agriculture and Forestry, August 2008) at ch 1.

15 Taylor and others, above n 4, at 125.

16 Kim, above n 1, at v.

accumulating in our soil from fertiliser such as fluorine, arsenic, mercury, lead and uranium.[17] New Zealand has yet to develop risk-based guidelines for uranium and fluoride despite these following a not dissimilar accumulation path as cadmium.[18]

New Zealand's farmed soils have on average more than six times the amount of cadmium as our unmodified background soils.[19] Other sources of anthropogenic cadmium contamination can also include manures, sewage sludge, pesticides[20] and lime.[21]

2.2 Human Tolerance

Cadmium found in food is the main source of human exposure for the non-smoking general population[22] (cadmium "concentrations in smokers are on average 4–5 times higher than those in non-smokers").[23] Accumulation of cadmium over long periods may lead to toxic concentrations in body tissues.[24] Cadmium primarily accumulates in kidneys, which can lead eventually to renal dysfunction.[25] There is scientific disagreement about whether exposure to cadmium, "at the low levels seen in most populations, contributes to the development of clinically relevant outcomes such as chronic kidney disease".[26] Yet the International Agency for Research on Cancer, a joint intergovernmental

17 Loganathan and others, above n 12, at 504; W de Vries and MJ McLaughlin "Modeling the cadmium balance in Australian agricultural systems in view of potential impacts on food and water quality" (2013) 461 Science of the Total Environment 240 at 241.

18 MD Taylor and others "A review of soil quality indicators and five key issues after 12 yr soil quality monitoring in the Waikato region" (2010) 26 Soil Use and Management 212 at 222.

19 Taylor and others, above n 18, at 222.

20 Anthony Kachenko and Balwant Singh "Heavy Metals Contamination in Vegetables Grown in Urban and Metal Smelter Contaminated Sites in Australia" (2006) 169 Water, Air, and Soil Pollution 101 at 102.

21 RD Longhurst *Envirolink 7 HBRC soil cadmium* (AgResearch, August 2006) at 7.

22 European Food Safety Authority "Scientific Opinion of the Panel on Contaminants in the Food Chain on a request from the European Commission on cadmium in food" (2009) 980 EFSA Journal 1 at 18.

23 Lars Järup and others "Health effects of cadmium exposure — a review of the literature and a risk estimate" (1998) 24(1) Scandinavian Journal of Work, Environment & Health 1 at 7.

24 European Food Safety Authority Panel on Contaminants in the Food Chain *Statement on tolerable weekly intake for cadmium* (European Food Safety Authority, 2011) at 18.

25 European Food Safety Authority, above n 24, at 5.

26 Laura DK Thomas "Dietary cadmium exposure and chronic kidney disease: A population based prospective cohort study of men and women" (2014) 217 International Journal of Hygiene and Environmental Health 720 at 720.

agency under the World Health Organization (WHO), assesses cadmium and cadmium compounds as carcinogenic to humans.[27]

Based on the WHO guidelines the majority of New Zealand's population's dietary exposure falls well within the lifetime dietary tolerance. However, when measured against the far stricter tolerance levels regulated in the European Union our diets have far less of a safety margin particularly for higher-risk individuals (see part 5.1 below).

2.3 Superphosphate

New Zealand's primary source for phosphate fertiliser for decades was the phosphate rock from Nauru derived from bird guano which contained very high levels of cadmium. Marine bird guano deposits are naturally high in cadmium which reflects "the marine food web transfer of cadmium from water into pelagic birds".[28] High levels of cadmium in guano are explained by *bio-accumulation* and *bio-magnification* processes where concentrations of a contaminant are absorbed and magnify as they are consumed by the next trophic level of the food chain.[29]

During the 1960s and the 1970s "the subsidisation of fertiliser in New Zealand led to its liberal application on farmland".[30] Soils that received a high level of phosphate fertiliser have higher levels of cadmium.[31]

There are no regulations in New Zealand limiting the metal content of fertilisers. This is a thorny area because: "Identification of limits for Cd in fertilizers is remarkably complex because so many different aspects of agriculture can influence Cd accumulation and bioavailability."[32] Nauru-sourced phosphate rock averaged around 450 mgCd/kgP[33] (up to 480 mgCd/

27 International Agency for Research on Cancer "Cadmium and Cadmium Compounds" in *Arsenic, Metals, Fibres and Dusts — IARC monographs on the evaluation of carcinogenic risks to humans: Volume 100C* (World Health Organization, 2012) at 141.

28 Erik Smolders and Jelle Mertens "Cadmium" in BJ Alloway (ed) *Heavy Metals in Soils: Trace Metals and Metalloids in Soils and their Bioavailability* (3rd ed, ebook ed, Springer, 2012) 283 at 287.

29 Ida Beathe Øverjordet and others "Effect of diet, location and sampling year on bioaccumulation of mercury, selenium and cadmium in pelagic feeding seabirds in Svalbard" (2015) 122 Chemosphere 14.

30 Taranaki Regional Council *Cadmium in Taranaki soils: An assessment of cadmium accumulation in Taranaki soils from the application of superphosphate fertiliser* (Taranaki Regional Council, 2005) at 3.

31 Philip Heatley and others *Farm Issues Management: Nutrient Management* (Dairying and the Environment Committee, 2006) at [3.9.1].

32 Chaney, above n 6, at 66.

33 Cadmium Working Group, above n 14, at ch 6.

kgP) although it was blended to dilute its cadmium content to range between 200 and 450 mg/kg from the late 1970s.[34]

In 1995 New Zealand's fertiliser manufacturers voluntarily phased out Nauru phosphate to reduce the maximum cadmium levels. The current voluntary industry limit is 280 mgCd/kgP.[35] Independent audits from 2001–2005 found the average level was 175 mgCd/kgP[36] and 2011 figures report an average of 180 mgCd/kgP.[37]

These reductions do not seem to go far enough as fertilisers with cadmium concentrations 140 mgCd/kgP and above are considered to result in relatively high accumulation in agricultural soils over 100 years.[38] "To prevent cadmium accumulation in soil, phosphate fertiliser would need to contain about 50 mg Cd/kg P."[39]

Today the majority of rock phosphate used in New Zealand is sourced from Morocco which is now the world's largest supplier of rock phosphate.[40] With this source come ethical concerns as this rock comes from Moroccan-controlled occupied lands of the Western Sahara.[41] "This area is subject to a United Nations mediated process, the outcome of which may impact on long term supply."[42]

Currently there is no cost-effective method of removing cadmium from phosphate rock and alternative low-cadmium phosphate has very limited availability and is expensive to source.[43]

Phosphate rock is a concentrated non-renewable source of phosphorus (as opposed to organic sources such as food waste or manures) and is becoming more scarce and expensive.[44] After an enormous price spike in 2008, rock prices

34 At ch 3.
35 At ch 3.
36 At ch 3.
37 GJ Rys "A national Cadmium Management Strategy for New Zealand agriculture" in LD Currie and CL Christensen (eds) *Adding to the Knowledge Base for the Nutrient Manager* (Fertilizer and Lime Research Centre, Massey University, Occasional Report 24, 2011) at 1.
38 European Commission Scientific Committee on Toxicity, Ecotoxicity and the Environment *Opinion on Member State assessments of the risk to health and the environment from cadmium in fertilizers* (European Commission Directorate-General Health and Consumer Protection Directorate C, 24 September 2002) at 2.
39 Ballance Agri-Nutrients "Fact sheet for cadmium" (2005) <www.ballance.co.nz>.
40 S Van Kauwenbergh *World Phosphate Reserves and Resources* (International Fertilizer Development Centre, 2010) at 85.
41 Dana Cordell and Stuart White "Peak Phosphorus: Clarifying the Key Issues of a Vigorous Debate about Long-Term Phosphorus Security" (2011) 3 Sustainability 2027 at 2039–2040.
42 Cadmium Working Group, above n 14, at ch 3.
43 At ch 3.
44 D Cordell and others "Towards global phosphorus security: A systems framework for phosphorus recovery and reuse options" (2011) 84 Chemosphere 747.

are now about four times higher than they were before 2006.[45] Whilst there is much debate, some estimates suggest "peak phosphorus" will occur in around 20 years, after which global demand will outstrip supply.[46] Countries with reserves of low-cadmium phosphate rock are capitalising on its value:[47]

> Sources such as the North Carolina rock have been denied to the New Zealand industry as they are classified as "strategic resources" and only exported in a value added form …

Another reason to implement careful management of fertiliser use is that fertiliser runoff or leaching is of concern to our freshwater systems causing eutrophication of waterways from excessive nitrogen and phosphate, requiring it to be strictly controlled in future.[48] Cadmium runoff and leaching may also present future concerns. However, little research has been conducted into its prevalence and effects (see part 2.7 below).

It seems we can slow cadmium accumulation rates through using fertiliser containing lower cadmium concentrations. In light of the fertiliser manufacturers' reluctance to lower their voluntary levels it is suggested that regulation should be imposed. This will cause pricing increases, a cost that should be passed on to the businesses that use fertiliser. It is the cost of more sustainable farming rather than the current unsustainable levels of cadmium inputs.

2.4 Plant Uptake into our Food Chain

Cadmium is readily absorbed into plants through their roots,[49] which is exacerbated by New Zealand soils having naturally high levels of acidity.[50] Soil pH has been identified as a dominant factor in plant uptake of cadmium with uptake significantly increasing in acidic soils.[51] Plants also uptake cadmium at very different rates depending on species, variety, soil type, condition, pH and zinc levels.[52] "Risk levels for specific crop varieties are unknown, yet they can

45 Reyes Tirado and Michelle Allsopp *Phosphorus in agriculture: Problems and solutions* (Greenpeace Research Laboratories Technical Report 02, 2012) at 3.
46 At 12.
47 Cadmium Working Group, above n 10, at 3.
48 Parliamentary Commissioner for the Environment, above n 8, at 88.
49 Smolders and Mertens, above n 28, at 297.
50 Kim, above n 1, at 14.
51 Ministry for the Environment *Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health* (Ministry for the Environment, June 2011) at 84.
52 Alina Kabata-Pendias and Henryk Pendias *Trace Elements in Soils and Plants* (3rd ed, ebook ed, CRC Press, 2001) at 5.

have an overriding effect relative to all other factors."[53] Yet while plant uptake "varies with crop type, a crop will uptake Cd according to availability in the soil".[54]

Green leafy vegetables tend to accumulate higher levels of cadmium than root vegetables and grains; however, they make up a lower proportion in our diets.[55] Spinach, for example, has been described as a hyper-accumulator for cadmium[56] which means spinach takes up significant amounts of cadmium. Amongst non-leafy greens, potatoes and grains are known as some of the more sensitive crops, and depending on their variety they can uptake far larger levels in relation to other crops.[57]

The fastest rate of cadmium accumulation in horticultural soils is for those used to grow potatoes, a result largely explained by higher fertiliser use.[58] By comparison, fruit tree uptake is generally low compared to that by vegetables.[59] As plants naturally imbibe cadmium it is unsurprising that vegetarians have higher levels of cadmium intake due to the larger amount of this plant matter in their diets.[60] Some potato varieties accumulate significant levels of cadmium.

These factors mean we find ourselves faced with multiple issues to manage: a history of particularly high cadmium phosphate application; applied to highly acidic soils; which results in an even greater uptake by crops destined for our dinner tables.

2.5 Cadmium Levels in Soils

Land usage is a key indicator for topsoil cadmium concentrations.[61] Cadmium content in soil varies from a range of factors including the soil type, historical

53 Fertiliser Association of New Zealand *Code of Practice for Nutrient Management Factsheet 12A* (Fertiliser Association of New Zealand, 2013) at 4.

54 RW McDowell "Is cadmium loss in surface runoff significant for soil and surface water quality: a study of flood-irrigated pastures?"(2010) 209 Water, Air, & Soil Pollution 133 at 134.

55 Brian Alloway and others "The accumulation of cadmium by vegetables grown on soils contaminated from a variety of sources" (1990) 91 Science of the Total Environment 223 at 224.

56 Darshana Salaskar, Manoj Shrivastava and Sharad P Kale "Bioremediation potential of spinach (Spinacia oleracea L.) for decontamination of cadmium in soil" (2011) 101(10) Current Science 1359 at 1361.

57 Kim, above n 1, at 4.

58 Taranaki Regional Council, above n 30, at 8.

59 Ministry for the Environment *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand: module 4 Tier 1 soil acceptance criteria* (Revised 2011) (Ministry for the Environment, 2011) at 22.

60 European Food Safety Authority, above n 22, at 2.

61 Cadmium Working Group, above n 14, at ch 1.

fertiliser use, the dominant land use, and climate.[62] Figures reported by the Cadmium Working Group in 2010 show the national average baseline (or natural background level) of cadmium is 0.16 mg/kg of soil[63] and the national average concentration across all agricultural land classes is 0.35 mg/kg.[64]

The figures below highlight the relative impact of different land uses on cadmium levels in topsoil samples.

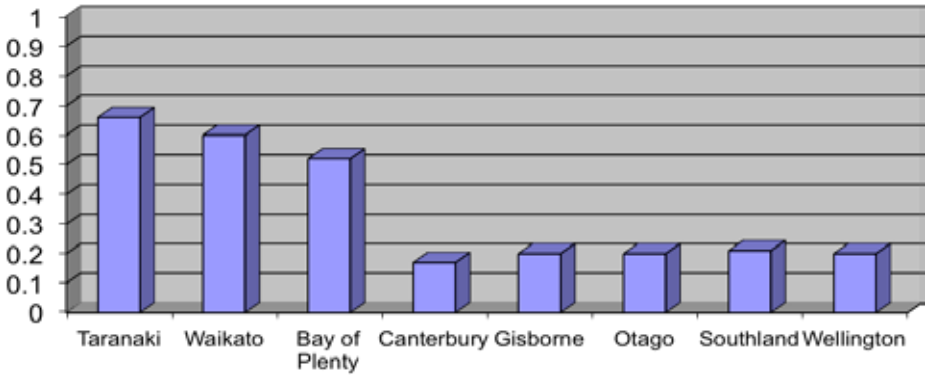
Figure 1: Average cadmium concentrations in soil per land usage type[65]

Land usage	**Cadmium mg/kg in soil**
National average	0.35
Dairy	0.73
Kiwifruit	0.71
Berry farms	0.68
Orchards	0.66
Market gardens	0.46
Beef	0.40
Sheep	0.33
Plantation forestry	0.14
Native forest	0.10

When analysed by region the areas with the highest average cadmium concentrations are Taranaki (0.66 mg/kg), the Waikato (0.60 mg/kg) and Bay of Plenty (0.52 mg/kg) which traditionally have had a higher proportion of dairy farming, whereas the regions found to have the lowest cadmium average concentrations were all historically sheep farming areas.[66] These figures may have held a level of alarm when they were released in 2007 because at that time the soil guideline trigger value was 1 mgCd/kg soil; however, it has subsequently been revisited under the Cadmium Management Strategy in 2011 and has effectively been raised by the addition of three new successively higher guideline values (see discussion at part 4.4 below).

62 At ch 1.
63 Ranging between 0 to 0.77 mg/kg; Cadmium Working Group, above n 10, at 3.
64 Ranging between 0 to 2.52 mg/kg; Cadmium Working Group, above n 10, at 3.
65 Adapted from Taylor and others, above n 4, at 5.
66 Taylor and others, above n 4, at 13.

Figure 2: Average soil levels of cadmium mg/kg by region[67]



A 2013 Fertiliser Association of New Zealand newsletter[68] reported: "Industry data indicate that 70% of New Zealand farms have cadmium levels within the range of naturally occurring levels of cadmium."[69] This can be seen on the graph above. "Of the 30% of samples above this level, 1% exceed the top management value for soil management."[70] This statement could mean we have little to worry about, but what it does not tell us is the rate at which further accumulation will occur. To date projections have been made but with little tangible data.[71] The best we currently have is a recent Landcare review that found: "No clear trends of increasing (or decreasing) concentrations over time for different land uses were identified."[72] The report recommends that further research be conducted. This is important as significant areas of former sheep farms have been converted to dairy over the last 30 years which equates to increasing accumulation in areas where previously there may have been none.

2.6 Pastoral Farming

The majority of productive land that is known to contain the higher levels for cadmium is currently used for grazing animals where the effect of their exposure goes almost unnoticed. The reason for this is because of the animals' shortened lifespans and the fact that cadmium primarily concentrates in a mammal's organs, particularly kidneys and liver, and not in significant levels

67 Adapted from Taylor and others, above n 4, at 13.
68 Fertiliser Association of New Zealand "Cadmium levels well within guidelines" 60 Fertiliser Matters (Fertiliser Association of New Zealand Newsletter, April 2013).
69 At 1.
70 At 1.
71 See Kim, above n 1, at 4, and Longhurst, above n 21, at 15.
72 Cavanagh, above n 5, at 18.

in the animal's meat or milk.[73] To protect our food chain and comply with EU import requirements the meat industry has prohibited the sale of offal for human consumption from animals over 30 months old.[74]

The rapid expansion of dairy in New Zealand presents significant challenges to managing cadmium levels in soil at the current rates of application and accumulation. Dairy farms require more fertiliser than any other land-use type due to dairy farming involving intensive grazing.[75] Numbers of dairy cows have increased from 2.4 million in 1990 to around 6.7 million in 2014, a figure from Statistics New Zealand,[76] although a more conservative figure comes from Dairy New Zealand of just over 4.9 million as at 2014.[77] This intensification however has come at the cost of increased pollution of our soils and freshwater systems. There was a 100 per cent rise reported in agricultural phosphate fertiliser use in New Zealand between 1990 and 2005.[78] This rapidly dropped following record-high fertiliser prices in 2008 but is increasing again.[79]

2.7 Cadmium Leaching and Runoff into Waterways

This section highlights the fact that contaminating soil with cadmium does not stop on the land but travels into groundwater and waterways with uncertain effects.

Little research has been done into soil cadmium losses to freshwater systems. Cadmium is a potentially biotoxic metal in aquatic ecosystems.[80] "Whether it is biotoxic or not will depend upon the concentration in the soil, its bioavailability and its potential transfer through the ecosystem."[81] Under acidic soil conditions cadmium is believed to move more readily in dissolved

73 JW Copius Peereboom and others "Exposure and health effects of cadmium part 2: toxic effects of cadmium to animals and man" (1981) 4 Toxicological & Environmental Chemistry 67 at 86.

74 Rys, above n 37, at 1.

75 Statistics New Zealand *Fertiliser Use and the Environment* (Statistics New Zealand, August 2006) at 3.

76 Liz MacPherson "Agricultural Production Statistics: June 2014 (provisional)" (16 December 2014) Statistics New Zealand <www. stats.govt.nz>.

77 Dairy New Zealand *New Zealand Dairy Statistics 2013–14* (Dairy New Zealand, 2014) at 7.

78 New Zealand Conservation Authority *Protecting New Zealand's Rivers* (New Zealand Conservation Authority, Wellington, 2011) at [11] quoting the Land and Water Forum (September 2009) at 15.

79 New Zealand Fertiliser Manufacturers' Research Association 57 Fertiliser Matters (New Zealand Fertiliser Manufacturers' Research Association Newsletter, March 2012).

80 McDowell, above n 54, at 133.

81 At 133.

form from soils into the catchment drainage system.[82] Erosion of pasture soils also causes the transport of cadmium into waterways, as does dispersal of superphosphate fertiliser directly into water bodies from top dressing and application too close to waterways.[83]

A New Zealand study on cadmium leaching into groundwater found that "measured Cd leaching losses equate to between 5 and 15% of the Cd added in each annual application", a finding which indicated the cadmium was fairly immobile in soil.[84] Exceptions may exist to this in "sandy soils of low adsorptive capacity".[85] Runoff and erosion present a different set of factors. In pastoral catchments surface water runoff of cadmium from superphosphate granules and particles comprises the primary means by which cadmium is likely to be transferred from land to water.[86] Despite low dissolved concentrations in New Zealand waters, "the influx of particulate-bound cadmium is apparently resulting in the gradual accumulation of this metal in freshwater (and possibly coastal) sediments".[87]

These processes are complex but greater understanding of them is required if we are to better manage any future risks of adding cadmium to our waterways. A study that looked at the relationship of cadmium concentrations in estuarine shellfish and fertiliser from the nearby pastoral farming catchment found that:[88]

> In more acidic soils, soil cadmium is mobile, desorbing into percolating soil water and passing into the catchment drainage system. It is likely, however, that when this leached cadmium reaches the higher pH in the fresh water streams, pH 6-7, most of the cadmium is readsorbed onto sediment. This readsorption process would favour the small particles, thus, ensuring the effective transport of soil cadmium into the estuary where the particulate cadmium becomes exposed to saline conditions … Cadmium adsorbed to fresh water sediment becomes soluble when the sediment is exposed to saline conditions.

The authors used this reasoning to suggest that cadmium from fertiliser "could become a significant management problem for shellfish aquaculture because countries limit the amount of this metal in their domestic and imported food".[89]

82 Catherine A Butler and Michael H Timperley "Fertilised farmland as a source of cadmium in oysters" (1996) 181 Science of the Total Environment 31 at 32.
83 Kim, above n 1, at 86.
84 CW Gray, RG Mclaren and AHC Roberts "Cadmium leaching from some New Zealand pasture soils" (2003) 54 European Journal of Soil Science 159 at 163.
85 Kim, above n 1, at 87.
86 At 87.
87 At 91.
88 Butler and Timperley, above n 82, at 42.
89 At 31.

The risks are pertinent as New Zealand aquaculture is a growth industry[90] with its products exported to 79 countries, meaning we potentially have a lot to lose from increasing cadmium in our soils and its associated downstream effects.[91] One of the taglines for the aquaculture industry's international marketing relies on our "pristine waters".[92] Uncertainty surrounds the impacts of cadmium leaching and runoff.

3. THE CONTAMINATED LAND REGIME UNDER THE RMA

This part of the article discusses the RMA framework and how contaminating land is addressed under it and examines the local government role in implementing the law. An in-depth discussion of the regulatory scheme for soil and for food and other significant legislation follows this part.

3.1 Resource Management Act 1991

The Resource Management Act 1991 (RMA) is a single integrated resource management statute designed to regulate the sustainable management of the natural and physical resources in New Zealand. The RMA prescribes a hierarchical planning framework that consists of policy statements, national standards, regulations, plans, rules and procedures to implement the purpose of the Act. The pt 2 statement of purpose and principles governs the RMA's operation and interpretation.

Management of resources is further controlled by pt 3 of the Act which pertains to the duties and restrictions under the Act. For land the "fundamental principle is that any use of land is allowed by the RMA unless that use contravenes a national environmental standard or rule in an operative or proposed district or regional plan".[93] In practice the RMA functions primarily as an effects-based regime with a focus on creating planning controls for the effects of activities. Thus the imposition of specific policy and rules from central and local government is essential to giving effect to the broader RMA framework.

90 Ministry for Primary Industries *The Government's Aquaculture Strategy and Five-year Action Plan to Support Aquaculture* (Ministry for Primary Industries, April 2012).

91 Seafood New Zealand "Aquaculture" (2012) <www.seafoodnewzealand.org.nz>.

92 Seafood New Zealand, above n 91.

93 David Kirkpatrick and Bronwyn Carruthers "Land use, subdivision, designations, resource consent procedures and appeals" in Derek Nolan (ed) *Environmental and Resource Management Law* (5th ed, LexisNexis, Wellington, 2011) at [4.2].

3.2 Sustainable Management

The purpose of the RMA is the sustainable management of natural and physical resources.[94] Sustainable management is defined as "managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while":[95]

> (a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
> (b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
> (c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

3.3 Life-supporting Capacity

The courts have considered the scope of the term "life-supporting capacity" and it was held in *Canterbury Regional Council v Selwyn District Council* that:[96]

> Soil is a resource which has potential to meet reasonably foreseeable needs of future generations by forming an intrinsic part of the food chain and furthermore that the life supporting capacity of soils is not restricted to the organisms which may live within it but to its ability to produce oxygen, chemicals, and foodstuffs for the multiplicity of life upon this earth.

Applying this definition, cadmium contamination in crops and land can be seen as something that the Act considers should be safeguarded against.

It is easy to see that the contamination of productive land is completely at odds with the purposes section of the RMA. Contaminated land is a product of poor management; it is unsustainable in the long term with land becoming rendered unfit for purpose, reducing its life-supporting capacity, and without remediation, it will not meet the needs of future generations.

Because cadmium concentrations have not been sustainably managed we find ourselves in the realm of remedying or mitigating the effects potentially for large tracts of land which may be far more costly (eg the loss of offal market

94 Resource Management Act 1991, s 5.
95 Section 5.
96 *Canterbury Regional Council v Selwyn District Council* (1996) 2 ELRNZ 395 (EC) at 405.

access, site investigations, soil remediation, and loss of land use) than initial prevention would have been.

3.4 RMA Mandated Council Functions

3.4.1 Regional councils

Regional council functions in relation to soil contamination include:[97]

> the establishment, implementation, and review of objectives, policies, and methods to achieve integrated management of the natural and physical resources of the region:[98]
> …
> the control of the use of land for the purpose of—
> (i) soil conservation:
> …
> (v) the prevention or mitigation of any adverse effects of the storage, use, disposal, or transportation of hazardous substances:[99]
> …
> in respect of any coastal marine area in the region, the control (in conjunction with the Minister of Conservation) of—
> …
> (iv) discharges of contaminants into or onto land, air, or water …[100]

Regional councils primarily fulfil these functions by preparing regional plans which either allow these discharges as permitted activities or require resource consents to be obtained for certain discharges of contaminants. Regional councils also have the role of investigating land for the purposes of identifying and monitoring contaminated land. Councils maintain a contaminated site register for this purpose.

3.4.2 Territorial authorities

Territorial authority functions in relation to soil contamination include:[101]

> (a) the establishment, implementation, and review of objectives, policies, and methods to achieve integrated management of the effects of the use,

97 Resource Management Act, s 30(1).
98 Section 30(1)(a).
99 Section 30(1)(c)(i) and (v).
100 Section 30(1)(d)(iv).
101 Section 31(a) and (b).

development, or protection of land and associated natural and physical resources of the district:

(b) the control of any actual or potential effects of the use, development, or protection of land, including for the purpose of—

…

(ii) the prevention or mitigation of any adverse effects of the storage, use, disposal, or transportation of hazardous substances; and

(iia) the prevention or mitigation of any adverse effects of the development, subdivision, or use of contaminated land:

Territorial authorities primarily fulfil these functions by preparing district plans with rules which require a resource consent to be obtained for the development, subdivision, or use of contaminated land.

3.5 Discharges

Additionally the RMA broadly accounts for discharges onto land and farm leaching and runoff in that:[102]

(1) No person may discharge any—

(a) contaminant or water into water; or

(b) contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water; …

…

(2A) No person may discharge a contaminant into the air, or into or onto land, from a place or any other source, whether moveable or not, in a manner that contravenes a regional rule unless the discharge …

This section provides that a discharge captured by this provision will be unlawful unless there is a positive right to discharge under a rule in a regional plan, a resource consent, national environmental standard or regulations. Thus it provides an avenue to invoke the enforcement and offences sections under the Act for appropriate breaches.

3.6 In Summary

The RMA framework confers wide powers to regulate contaminants upon ministers and local government, which could include the application of, and constituents of, fertiliser, or cadmium levels in productive soil, either under

102 Section 15(1)(a) and (b) and (2A).

the uses of contaminated land, for the purposes of soil conservation, or the prevention or mitigation of any adverse effects of fertiliser use.

4. REGULATORY SCHEME: SOIL

This part of the article looks at the regulatory framework relating to contaminants in soils and finds it lacking central government policy for existing uses of production land. Moving further down the RMA hierarchy of documents, soil contaminant standards for cadmium do not apply in this area either (the narrow exceptions to this are explained in the following text). Instead the relevant measures come in the form of guidelines. The relevance of these regulations, standards and guidelines is discussed and explained below.

4.1 National Environmental Standard

National environmental standards are regulations made by the Ministry for the Environment. National environmental standards sit high up the RMA hierarchy as central government policy, and are designed to provide local government and decision-makers with clear parameters for implementing and managing resource management issues. They may "prescribe technical standards, methods or requirements for environmental matters such as contaminants".[103]

The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES) came into effect in 2012. The policy objective of this NES is to "ensure that land affected by contaminants in soil is appropriately identified and assessed at the time of being developed and if necessary remediated, or the contaminants contained, to make the land safe for human use".[104] It does this by providing a nationally consistent set of planning controls for contaminated land.[105] The NES specifically addresses territorial authority functions, which must ensure district plans are not inconsistent with the NES in accordance with their s 31 functions under the RMA: the "prevention or mitigation of any adverse effects of the development, subdivision, or use of contaminated land".[106] Regional council functions are not addressed by the NES.

103 Section 43.

104 Ministry for the Environment *Proposed National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health — Evaluation under Section 32 of the Resource Management Act* (Ministry for the Environment, 2011) at 1.

105 Ministry for the Environment "About the NES for Assessing and Managing Contaminants in Soil to Protect Human Health" (14 July 2014) <www.mfe.govt.nz>.

106 Resource Management Act, s 31(b)(iia).

The NES is designed to be triggered when land is being developed. Existing uses of land are not affected by the regulations. The NES only applies when one of the following five activities is contemplated: removing or replacing a fuel storage system; sampling the soil; disturbing the soil; subdividing land; and changing the use of the land.[107]

The scope of the NES relating to production land is narrower than other land. If the land that is potentially or actually affected by contaminants is production land, the regulations do not apply to:[108]

a. soil sampling or soil disturbance (except on parts of production land used for residential purposes)
b. subdivision or change of use (except where that would result in production land being used for a different purpose, eg, for residential land use).

"The NES only applies to land that is potentially or actually affected by contaminants because of its historical and/or current use and the types of activities previously undertaken on it."[109] What constitutes land *potentially or actually affected* is described by one of the following:[110]

(a) an activity or industry described in the *HAIL* is being undertaken on it:
(b) an activity or industry described in the *HAIL* has been undertaken on it:
(c) it is more likely than not that an activity or industry described in the *HAIL* is being or has been undertaken on it.

4.2 The Hazardous Activities and Industries List

The Hazardous Activities and Industries List (HAIL) is a list compiled by the Ministry for the Environment of activities and industries commonly associated with contaminated land. It is designed to assist local authorities in identifying potentially contaminated sites.[111] Productive land is included in the HAIL under the catch-all provision: "land that has been subject to the intentional or

107 Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011, cl 5 [National Environmental Standard].
108 Ministry for the Environment *Users' Guide: National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health* (Ministry for the Environment, April 2012) at 11; see National Environmental Standard, above n 107, at cl 5.
109 Ministry for the Environment, above n 108, at 10.
110 National Environmental Standard, above n 107, cl 7.
111 Ministry for the Environment *Hazardous Activities and Industries List (HAIL)* (17 May 2013) <www.mfe.govt.nz>.

accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment".[112]

The question of whether applying cadmium to the land via fertiliser is a HAIL activity will turn on the land use. This is because the measure of whether the cadmium is present in "sufficient quantity that it could be a risk to human health or the environment" relates to the guideline standard which varies depending on the land use. Productive land has a far lower guideline trigger value for investigation of 1.0 mgCd/kg than other uses in recognition of how it can directly translate to human and farm animal ingestion. By comparison the same land assessed under the NES soil guideline for rural residential land is 0.8 mgCd/kg, for residential soils is 3.0 mgCd/kg, or where the land will be used for high-density residential it is 230 mgCd/kg.[113]

The Ministry for the Environment has stated that the NES was created in response to the situation where "existing controls are either absent, inadequate or inconsistently applied".[114] The rationale for excluding "consideration of protecting the productive capacity of land and exceeding the maximum residue levels in food" was that this is dealt with by other legislation protecting public health.[115] "The safety of food produced for the general public is subject to the joint New Zealand Australian Food Standards. Testing under this jurisdiction is a more direct measure of determining whether this land is safe for human use."[116] There is logic in this approach as the NES is confined to controlling contaminants in soil to protect human health. There is of course much more at stake here in managing this resource than just human health. Yet the effectiveness of this other legislation to protect public health is weak because any actual scrutiny for the food safety contaminant levels of cadmium in vegetables and grains is only conducted every five years with a very small number of samples, and not for the purpose of determining if foods fall within permitted levels, but rather to determine how much cadmium an average diet includes.

Because NES does not apply to (most) existing uses of production land there is a gap in the central government policy for contaminated land. This leaves the existing land-use controls (council plans and rules) which could also be described as either *absent, inadequate or inconsistently applied.* Prior to the 2011 NES, in the absence of central government policy territorial authorities had to develop their own "identification and investigation processes in order to meet their functions under section 31 of the RMA. As a result, councils

112 Ministry for the Environment, above n 111.
113 Ministry for the Environment, above n 51, at x.
114 Ministry for the Environment, above n 104, at vi.
115 Ministry for the Environment, above n 51, at [3.2.2].
116 At [3.2.2].

throughout the country have, until very recently, often had very different approaches to addressing the potential for land contamination."[117]

Councils' latest (second-generation) regional and district plans are incorporating specific provisions and rules for fertiliser use to account for the risks its poses in relation to nutrient management, leaching and runoff effects. An example is the new 2014 "One Plan" for the Manawatu-Whanganui region which makes fertiliser use and storage a controlled activity for intensive farming.[118] This means the operation requires a resource consent which must comply with the standards and terms specified in the rule and is assessed according to the matters over which the Council has reserved its control.[119] The rule specifies adherence to the fertiliser industry "Code of Practice for Nutrient Management" but this is not designed to address cadmium accumulation.[120] No reference is made to the Cadmium Management Strategy and the Tiered Fertiliser Management System.[121]

Regulation for sampling the levels of cadmium in production soil appears to be put in the too-hard basket because of the dynamic nature of farming. But once a dairy farm is not always a dairy farm. "Changes to land use underscore a regulatory need to manage cadmium inputs in all areas."[122] Farms are businesses and requiring them to have their soil and crops tested to get baselines to confirm they conform with the soil contaminant guidelines and the food safety standards does not seem unduly onerous or unreasonable. "Knowledge of cadmium (Cd) concentrations in New Zealand agricultural soils is essential to manage the risks associated with soil Cd, and be able to implement the Tiered Fertiliser Management System …"[123] It is after all in a business's interest as they are then in a position to be able to begin managing this problem earlier rather than later.

A wider ambit for the NES would have been a prime opportunity to signal the change in land scrutiny required to deal with this developing problem. A 2012 report on soil guidelines mentions that the Ministry for the Environment had "recently scoped the policy development required to extend the National Environmental Standard to the protection of the wider environment" but to date no action appears to have been taken to act on this proposal.[124]

117 Waikato District Council *State of the environment report*: *Contaminated land* (Waikato District Council, 2013) at 2.

118 Horizons Regional Council *One Plan* — "Chapter 14: Discharges to Land and Water" (Horizons Regional Council, 2014) r 14-1.

119 Resource Management Act, s 77B.

120 Fertiliser Association of New Zealand *Code of Practice for Nutrient Management* (Fertiliser Association of New Zealand, 2013).

121 Horizons Regional Council, above n 118, r 14-1.

122 Kim, above n 1, at iv.

123 Cavanagh, above n 5, at v.

124 Jo Cavanagh *Working towards New Zealand risk-based soil guideline values for the*

4.3 Soil Contaminant Standards

The Ministry for the Environment has adopted a risk-based *Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health.*[125] Cadmium is one of the 12 priority contaminants listed of primary concern in New Zealand. The soil contaminant standards (SCSs) have regulatory status under the NES. As a result of the NES not addressing existing land uses there are no national-level standards with the status of regulations for the permissible amount of cadmium in existing use production soils, or for the discharge of cadmium onto production soil. Where the SCSs do become relevant is where a land-use change is proposed — for example, to rural residential land which allows for home-grown produce and has a low threshold of 0.8 mgCd/kg soil (at pH 5).[126]

4.4 Soil Guideline Values

In the absence of regulatory SCSs instead soil guideline values (SGVs) are the relevant protocol. SGVs are created by a number of different players from industry bodies to health authorities and may include adopted overseas standards. A soil guideline is "a concentration value of a contaminant in soil to which people and/or ecological receptors (e.g. worms or plants) that are living on a site can be exposed with an acceptable level of risk".[127] If human health guidelines are exceeded a potential human health risk exists.[128] Until 2011 the applicable guideline was for cadmium levels in biosolids applied to agricultural land which was used as a default measure for fertiliser.[129] The biosolids guidelines published in 2003 replaced the former Department of Health guideline of 3 mg/kg with a trigger guideline value for further investigation of cadmium in agricultural soils of 1 mg/kg.[130]

However, this was superseded in 2011 by the development of the Tiered Fertiliser Management System (TFMS) created under the Cadmium Management Strategy. Whilst 1 mg/kg is still the investigation trigger guideline, there are three new levels above it which have recalibrated the level of concern

management of cadmium accumulation on productive land (Ministry of Primary Industries Technical Paper No: 2012/06, June 2012) at 9.

125 Ministry for the Environment, above n 51.

126 Ministry for the Environment, above n 51, at 99.

127 Jo-Anne E Cavanagh *Comparison of Soil Guideline Values used in New Zealand and Their Derivations* (Landcare Research, November 2006) at 7.

128 At 7.

129 National Environmental Standard, above n 107, cl 5(8).

130 New Zealand Water and Wastes Association *Guidelines for the Safe Application of Biosolids to Land in New Zealand* (New Zealand Water and Wastes Association, August 2003) at 116.

around the 1 mg figure. The TFMS contains a new higher guideline level of 1.8 mgCd/kg which acts as a cut-off point:[131]

Figure 3: Cadmium management tiers and tier boundary trigger values[132]

Tier	Management action required	Cadmium concentration	Trigger value
0	5-yearly screening soil test for cadmium status	0–0.6 mg/kg	0.6 mg/kg
1	Application is restricted to a set of products and application rates to minimise accumulation, and landholders are required to test for cadmium every 5 years using approved programmes	> 0.6–1.0 mg/kg	1.0 mg/kg
2	Application rates are further managed by a cadmium balance programme to ensure that cadmium does not exceed an acceptable threshold within 50 years	> 1.0–1.4 mg/kg	1.4 mg/kg
3	Application rates are further managed by use of a cadmium balance programme to ensure that cadmium does not exceed an acceptable threshold within the 50 years	> 1.4–1.8 mg/kg	1.8 mg/kg
4	No further accumulation	> 1.8 mg/kg	

As a voluntary scheme these guidelines only become legally binding when councils give them legal effect by incorporating them into a regional or district plan, or as a condition of resource consents.[133] This author has not found any evidence of this incorporation. Councils however are not unaware of the issues cadmium presents — for example, now "many regional councils include trace element analyses as part of their regular soil quality monitoring programmes".[134]

4.5 What is "Contaminated" Land?

The RMA defines "contaminated land" as:[135]

> … land that has a hazardous substance in or on it that—
> (a) has significant adverse effects on the environment; or

131 Cavanagh, above n 124, at 9.
132 Adapted from Cavanagh, above n 124, at 1.
133 Cadmium Working Group, above n 14, at ch 2.
134 Cavanagh, above n 5, at 1.
135 Resource Management Act, s 2.

(b) is reasonably likely to have significant adverse effects on the environment

The RMA's "hazardous substance" definition is taken directly from the Hazardous Substances and New Organisms Act 1996 which includes any substance with a variety of intrinsic properties that include toxicity (including chronic toxicity) or ecotoxicity, with or without bioaccumulation.[136] Cadmium falls into the definition of hazardous substance under the toxicity and ecotoxicity categories, but still must meet the test of having or being reasonably likely to have significant adverse effects on the environment. The relevant section states:[137]

Meaning of effect
In this Act, unless the context otherwise requires, the term **effect** includes—
(a) any positive or adverse effect; and
(b) any temporary or permanent effect; and
(c) any past, present, or future effect; and
(d) any cumulative effect which arises over time or in combination with other effects—
regardless of the scale, intensity, duration, or frequency of the effect, and also includes—
(e) any potential effect of high probability; and
(f) any potential effect of low probability which has a high potential impact.

High cadmium concentrations in arable land can be viewed as a significant adverse effect because it has a potential permanent effect (of high probability) of a future requirement for soil remediation or loss of soil resource from crops that exceed food guideline standards. The level which triggers this classification depends on the land use (or future land use) as the guidelines contain widely different levels for different land uses of the same piece of land.

The RMA definition refers to an effects-based model. Yet contaminated land practitioners in practice have to deal with the fact that each definition they deal with is prepared for, and only really works within, its own document and context. Australasian guidelines were first developed in the 1990s in recognition of the inconsistent and ad hoc approaches being taken.[138] These have been superseded by the implementation of the NES which takes the approach (and

136 The RMA definition references the Hazardous Substances and New Organisms Act 1996, s 2.

137 Resource Management Act, s 3.

138 Australian and New Zealand Environment and Conservation Council *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (Australian and New Zealand Environment and Conservation Council, 1992) at 2 defined a contaminated site as "a site at which hazardous substances occur at concentrations

is the working definition adopted by industry) that contaminated land is *land on which there is a contaminant above background levels*.[139] The basic test for this is to assess whether concentrations are above background or not; whether this contamination will have an adverse effect or not is a separate consideration.[140] Background concentrations can either be site-specific and adopted from nearby soils that are uncontaminated, or from broader regional studies.[141] This means there could be naturally occurring soil concentrations that are so high due to natural processes that it would be toxic to a human accidentally exposed to the contaminant. Conversely, there could be a site that is contaminated but sits below the maximum acceptable concentrations.[142] If something is contaminated, and the levels are in excess of what is safe, then remediation or management is required to prevent it being a hazard, assuming the owner wants to and there is a statutory requirement to make it safe.[143]

5. REGULATORY SCHEME: FOOD

This part of the article begins by looking at the international acceptance of safe dietary exposure for cadmium in food and the surrounding controversy. It then discusses the New Zealand and Australian regulatory approach, and later traverses the difficulty of setting safe soil guidelines alongside safe levels of cadmium in food as the two often do not correlate.

5.1 Guidelines for Cadmium in Food

The joint New Zealand and Australian guidelines follow the Joint Expert Committee on Food Additives (JECFA) from the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). JECFA/WHO guidelines for a provisional tolerable monthly intake (PTMI) of cadmium is 25 µg/kg of body weight.[144] This corresponds to a weekly intake of 5.8 µg/kg bw

above background levels and where assessment indicates it poses, or is likely to pose an immediate or long-term hazard to human health or the environment" (endnotes omitted).

139 See National Environmental Standard, above n 107, cl 5(9).

140 Email from Jade McConchie (Geo-Environmental Scientist) to Catherine Dearsley (author) regarding "What then is contaminated land?" (14 January 2014).

141 See, for example, Auckland Regional Council *Background Concentrations of Inorganic Elements in Soils from the Auckland Region: Technical Publication No. 153* (Auckland Regional Council, October 2001) at 26.

142 McConchie, above n 140.

143 McConchie, above n 140.

144 Food and Agriculture Organization and World Health Organization *Summary and Conclusions Seventy-third meeting of the Joint FAO/WHO Expert Committee on Food*

(which was lowered in 2010 from their previous figure of 7 µg/kg bw/week).[145] PTMI is an estimate of the amount of a chemical that can be ingested monthly over a lifetime without appreciable health risk.[146] Because of the long-term effects of cadmium, JECFA's recent position is that it is appropriate to express cadmium intakes as monthly intakes.[147]

In contrast the European Food Safety Authority (EFSA) Panel on Contaminants in the Food Chain has maintained a far more conservative tolerable *weekly* intake of 2.5 µg/kg body weight (equating to 10 µg/kg body weight monthly, which is less than half the 25 µg/kg FAO/WHO guideline). In 2011 the EFSA re-examined their position in light of the adjusted FAO/WHO guideline and found the differences were due to the interpretation of the same dataset of studies. They concluded that the EU guidelines were still appropriate, stating that these levels are "designed to ensure sufficient protection of all consumers".[148] The EFSA has estimated the mean dietary exposure across European countries to be 2.3 µg/kg body weight per week[149] but report that vegetarians have a far higher dietary exposure of up to 5.4 µg/kg body weight per week, because of their proportionately higher consumption of cereals, nuts, oilseeds and pulses,[150] a figure which exceeds the European standard but falls within the FAO/WHO guidelines.

Dietary surveys for New Zealanders' daily intake of cadmium indicate it is well within the WHO guidelines. For a child (aged 1–3 years) the intake is estimated to be 12.5 µg/kg body weight per month and for adults 7.9 µg/kg body weight per month (the survey accounts for five different age and sex groups in total).[151] These estimates were primarily based on the 2003/04 New Zealand Total Diet Survey (NZTDS).[152] No figures are currently calculated for vegetarians who make up only a small proportion of the population.

It is important to note that the chronic aspect of cadmium risk requires a high consumption of foods containing higher than normal levels of bioavailable (able to be absorbed) cadmium for decades before adverse effects are expected

Additives (World Health Organization, 2010) at 12. Note: µg is the metric symbol for microgram.

145 European Food Safety Authority "Cadmium dietary exposure in the European population" (2012) 10(1) EFSA Journal 2551 at 2552.

146 Soisungwan Satarug and others "Cadmium, Environmental Exposure, and Health Outcomes" (2010) 1181 Environmental Health Perspectives 182.

147 Food and Agriculture Organization, above n 144, at 12.

148 European Food Safety Authority, above n 145, at 1.

149 European Food Safety Authority, above n 24, at 2.

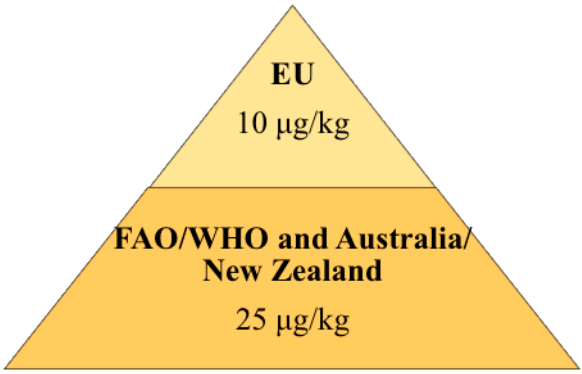
150 At 2.

151 Ministry for the Environment *Toxicological Intake Values for Priority Contaminants in Soil* (Ministry for the Environment, June 2011) at ix.

152 At 5.

to occur.[153] Some of our population such as vegetarians may fall into this category.

Figure 4: Differences in provisional tolerable monthly limits expressed as µg/kg per body weight



Note: European vegetarians are assessed to have a monthly intake of 21.6 µg/kg body weight.

The difference in these approaches reflects a divergence in scientific opinion around safe levels and an appetite for risk. Over time it is becoming apparent that food-chain risks from cadmium are very complex and our understanding of chronic dietary exposure is hindered because it is difficult to replicate decades of low-level ingestion in laboratories.[154] As further research comes to light it has the potential for the tolerance values to be readjusted as has already occurred for the soil and food contaminant standards.[155] It may also have bearing on our future exports if the EU regulatory requirements follow through to a preference in their trading partners with low soil cadmium and produce.[156]

5.2 Challenges to "Safe Intake" Tolerances

As noted earlier there are several stances when it comes to what levels of cadmium exposure may cause chronic disease.[157] One researcher has recently argued that poor science has led the scientific field to a host of "misunderstandings of the effect of soil factors, food-chain factors, and human factors in risk from soil or fertilizer Cd to humans"; "different foods have quite different bioavailability of Cd in the food"; and "excessive concern based on

153 Chaney, above n 6, at 66.
154 At 62.
155 Cadmium Working Group, above n 10, at 1.
156 Kim, above n 1, at 4.
157 Chaney, above n 6, at 53.

poor science could lead to unnecessarily restrictive limits on trace elements in fertilizers, and raise the costs of these products and of foods to consumers".[158]

There is research which reports an inconclusive link that cadmium "contributes to the development of clinically relevant outcomes".[159] But there are numerous studies which tend to contradict this view and there are scientists who argue that the current WHO safe intake level of this carcinogen does not provide sufficient health protection and that it should be lowered,[160] because adverse health effects of cadmium exposure may "occur at lower exposure levels than previously anticipated".[161] They point to epidemiological studies that link low-level cadmium exposure with some adverse effects that are not restricted to the well-known kidney and bone disorders, and include "almost every organ and tissue where cadmium accumulates, including eye tissues".[162] They suggests that more research is required because the "high prevalence of cadmium exposure means that even a small increase in risk could yield a large number of preventable cancer cases".[163] They argue that the current data suggests more stringent public health measures should be put in place aimed at reducing current exposure to cadmium from food.[164] Other researchers support this view; one US study concludes: "Efforts to further reduce cadmium exposure in the population could contribute to a substantial decrease in CVD [cardiovascular disease] burden."[165] Another states: "Cadmium appears to be associated with overall cancer mortality in men and women, but the specific cancers associated differ between men and women, suggesting avenues for future research."[166] Indeed the majority of medical research canvassed for this article concludes by calling for further research to be done as this is a developing area. Widespread, low-level population ingestion of cadmium from food is after all a recent phenomenon.

Certainly the science is complex. Because there are so many factors involved, the question of whether long-term health complications are caused by a contaminant may often polarise researchers. There's the need to take a

158 At 68, 64 and 53.

159 Thomas, above n 26, at 720.

160 Satarug and others, above n 146, at 182.

161 Lars Järup "Hazards of heavy metal contamination" (2003) 68 British Medical Bulletin 167 at 167.

162 Satarug and others, above n 146, at 188.

163 At 188.

164 At 188.

165 Maria Tellez-Plaza and others "Cadmium exposure and all-cause and cardiovascular mortality in the U.S. general population" (2012) 120 Environmental Health Perspectives 1017 at 1017.

166 Scott V Adams and others "Cadmium exposure and cancer mortality in the Third National Health and Nutrition Examination Survey cohort" (2012) 69 Occupational and Environmental Medicine 153 at 153.

precautionary approach where science is unsettled and this is what international policy-makers and New Zealand's response has been. One could argue however that they need to take stronger precautions more in line with that of the EU.

5.3 Food Safety Standards versus Soil Guideline Values

If there is a potential future health-care burden from the increasing cadmium levels in our food, this may arguably be prevented by intervention at the soil level by stricter fertiliser standards to lower the application of cadmium to the soil rather than waiting until the contaminant is in the food chain. Yet there is also an argument that "extreme low" cadmium limits in phosphate fertiliser are "not supported by research on food-chain transfer of Cd from applied fertilizers".[167] This is based on the evidence that some varieties of plants grown on land that is well below the soil guideline level appear to regularly exceed the food standard.[168] Therefore we have two parallel but not necessarily intersecting sets of standards, as the soil contamination guideline was designed for a wider range of considerations than simply food and the food safety standards.

We know that some varieties of plants, such as some varieties of potatoes and grain grown on land that is well below the soil guideline, appear to regularly exceed the food standard, yet little, if anything, is being done to understand or manage this situation. To date in New Zealand "studies on plant uptake have been conducted on a limited number of species, and variation between cultivars has only been examined for wheat".[169] With almost no testing done of food we are largely in the dark as to the scale of the problem.[170] The regulation of cadmium in food (see part 5.4 below) is rendered ineffectual by the lack of testing of our food and plant varieties, or any resulting follow-up.

Further research is needed to understand better the frequency of occurrence as well as the end points for this contaminated food. Without more comprehensive understanding we cannot begin to address the problem of food that already exceeds the food standards. Much could be done to reduce dietary exposure for the higher-risk consumers such as the breeding and selection of plant cultivars to minimise cadmium accumulation.[171] Canada has since 2005

167 Chaney, above n 6, at 68.

168 CW Gray, RG McLaren and AHC Roberts "Cadmium concentrations in some New Zealand wheat grain" (2001) 29 New Zealand Journal of Crop and Horticultural Science 125 at 129.

169 Jo-Anne E Cavanagh, Ants Roberts and Warrick Catto "Phosphatic fertiliser — what do we need for the long-term management of soil cadmium?"(Paper presented to Australia New Zealand Fertilizer Industry Conference, Queensland, October 2013) at 6, referring to Gray and others, above n 168.

170 Kim, above n 1, at 4.

171 CA Grant and others "Selection and breeding of plant cultivars to minimize cadmium accumulation" (2008) 390 Science of the Total Environment 301.

regulated new durum wheat cultivars requiring them to carry a low cadmium accumulating trait.[172]

Quality assurance for our food chain should come from primary producers being required to test the soil that their produce comes from and ascertain that their crops fall within the food safety standards. The Fertiliser Association's recommended practice to reduce cadmium uptake into food crops includes measuring "cadmium level in soils and in edible plant parts (using an accredited laboratory)".[173]

5.4 Food Standards Code/Food Act 1981

Food Standards Australia New Zealand is a binational government agency that develops and administers the Australia New Zealand Food Standards Code.[174] The Code has the status of regulations made under the Food Act 1981.[175] The Act allows standards to be issued in relation to the composition of food, including maximum amounts for chemical contaminants.[176]

The Code lists maximum levels (MLs) of specified contaminants in food. A ML represents the amount of a substance that is legally permitted to be present in that food as a regulatory compliance tool.[177] The MLs for cadmium have only been listed for 10 different food types.[178]

The MLs were significantly reduced after the adoption of risk-based food standards. For cadmium they were 10 times higher than the current levels, having generally been reduced from 1 mg/kg to 0.1 mg/kg.[179] The Ministry for Primary Industries (MPI) has responsibility for assurances for the safety and suitability of domestic food and food-related products under the Food Act.[180] Industry testing for cadmium is done for milk and meat to ensure compliance with export trading partners' requirements. Otherwise MPI does not actively test for cadmium in food except in the five-yearly total diet survey.[181]

172 At 305.

173 Fertiliser Association of New Zealand, above n 53, at 4.

174 Food Standards Australia New Zealand *New Zealand (Australia New Zealand Food Standards Code) Food Standards 2002* (Food Standards Australia New Zealand, 2013).

175 Food Act 1981, s 11C.

176 Section 11C.

177 Kim, above n 1, at 12.

178 Food Standards Australia New Zealand, above n 174, Standard 1.4.1 Contaminants and Natural Toxicants.

179 Environmental Science Monitoring Group *Trace Element Concentrations in Some Marlborough Soils* (Marlborough District Council, November 2007).

180 Ministry of Primary Industries "MPI's legal responsibilities for food safety" (2013) <www.foodsafety.govt.nz>.

181 Although, also in 2009, the Food Residue Surveillance Programme analysed New Zealand garlic samples for cadmium. See Ministry of Primary Industries "Survey of chemical residues and heavy metals in imported garlic and ginger" (2009) <foodsafety.govt.nz>.

6. OTHER SIGNIFICANT LEGISLATION

This part of the article briefly discusses two additional Acts which create statutory obligations to control the adverse effects of fertiliser use, or in the case of the second Act, "hazardous substances".

6.1 Agricultural Compounds and Veterinary Medicines Act 1997

This Act provides a governance structure for the regulation of fertilisers and their use. The Act repealed the Fertiliser Act (1960 and 1982). The use of fertiliser receives ample cover under the purposes of the Act which is to:[182]

> (a) prevent or manage risks associated with the use of agricultural compounds, being—
> (ia) risks to public health; and
> (i) risks to trade in primary produce; and
> (ii) risks to animal welfare; and
> (iii) risks to agricultural security:
> (b) ensure that the use of agricultural compounds does not result in breaches of domestic food residue standards:
> (c) ensure the provision of sufficient consumer information about agricultural compounds.

The scheme of the Act relevant to this discussion is as follows:[183]

> (3) A range of conditions may be imposed to manage the risks associated with agricultural compounds. These conditions may relate to substances, products, systems, or people's behaviour, and may be imposed—
> …
> (b) generally, by regulations.
> …
> (5) This Act, by its subject matter, has a relationship with other Acts … Generally, the outcomes for which this Act regulates are those set under the other related Acts. For example:
> (a) maximum residue limits for food products are set under the Food Act 1981; while
> (b) this Act assesses and controls agricultural compounds to ensure the Food Act residue limit is not breached.

182 Agricultural Compounds and Veterinary Medicines Act 1997, s 4.
183 Section 4A.

The responsibility of managing the risks from fertiliser use and ensuring the food safety standards are not breached falls upon the Ministry for Primary Industries. MPI's food safety website states "the basic Government policy is to impose control that is 'necessary and sufficient' to manage risks while avoiding unnecessary costs of compliance". MPI has a very large sphere of governance and its funding has to be spread very widely. There are many contaminants and residues in food which MPI must survey. As cadmium risk is spread over a lifetime tolerance and the current understanding is that most of our diet falls well within this tolerance, these factors may account for the little attention that cadmium in our food from fertiliser has received.

6.2 Hazardous Substances and New Organisms Act 1996

The purpose of the Hazardous Substances and New Organisms Act 1996 (HSNO Act) is to "protect the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms".[184]

The principles relevant to the purpose of the Act are as follows:[185]

(a) the safeguarding of the life-supporting capacity of air, water, soil, and ecosystems:
(b) the maintenance and enhancement of the capacity of people and communities to provide for their own economic, social, and cultural well-being and for the reasonably foreseeable needs of future generations.

The Environmental Protection Authority (EPA) administers the HSNO Act and its responsibilities include regulating the use of hazardous substances and setting rules that apply.[186] The Act provides for the setting of exposure standards for substances with toxic or ecotoxic properties which cadmium falls under.[187] HSNO legislation amends the Food Act to require the Ministry of Health to consult with the Authority on food regulations, where residues or additives in foods are also hazardous substances under the HSNO Act.[188]

Section 13 of the Act imposes a positive duty upon "every person who imports, possesses, or uses a hazardous substance [to] ensure that any adverse effect caused by an act or omission of that person in relation to that substance on any other person or the environment is avoided, remedied, or mitigated".

184 Hazardous Substances and New Organisms Act 1996, s 4.
185 Section 5.
186 Environmental Protection Authority "Hazardous substances and new organisms" (2014) <www.epa.govt.nz>.
187 Hazardous Substances and New Organisms Act, s 77B.
188 Food Act, s 42(2A).

Notably the Act incorporates the precautionary principle taken from international law instruments:[189]

> **Precautionary approach**
> All persons exercising functions, powers, and duties under this Act … shall take into account the need for caution in managing adverse effects where there is scientific and technical uncertainty about those effects.

The precautionary principle has been developed as "a means of avoiding danger to human health and the environment in situations where there is a high degree of uncertainty and the effects of policy decisions are possibly irreversible".[190] However, the principle has been critiqued as offering little in the way of guidance for regulatory policy-makers.[191]

The HSNO Act provides the ability to regulate the levels of cadmium in fertiliser, potentially via the setting of exposure limits for the environment of substances with toxic or ecotoxic properties,[192] or the issue, or amending, of any code of practice for hazardous substances.[193] Currently most fertilisers fit into the EPA group standard called *subsidiary*.[194] Yet a sticking point at this level of regulation is that although cadmium is a hazardous substance because of its toxic and ecotoxic properties, in fertiliser it is only present at the levels of an impurity and it is not until it accumulates over decades in the soil that a problem manifests. Arguably applying the precautionary approach to limit the cadmium levels in fertiliser would go far to prevent and manage the adverse effects of it building up in the soil and eventually waterways and food.

7. AUSTRALIAN CADMIUM MANAGEMENT

Australia has a very similar history of cadmium accumulation in productive soils from phosphate fertiliser, and the development of a strategy for managing cadmium, as New Zealand. We share the same food standards and code under the common binational agency Food Standards Australia New Zealand. Past

189 Hazardous Substances and New Organisms Act, s 7.

190 Linda Cameron *Environmental Risk Management in New Zealand — Is There Scope to Apply A More Generic Framework?* (New Zealand Treasury, Policy Perspectives Paper 06, July 2006).

191 For further discussion see Bal Matheson "Hazardous Substances" in Derek Nolan (ed) *Environmental and Resource Management Law* (5th ed, LexisNexis, Wellington, 2015) at [11.8] and generally ch 11.

192 Hazardous Substances and New Organisms Act, s 77B.

193 Section 78(1).

194 Fertiliser Association of New Zealand, above n 120, at 49.

Australian studies have also demonstrated cadmium exceedances in Australian crops such as potatoes,[195] peanuts,[196] and leafy vegetables.[197]

Inputs of cadmium to agricultural soils are controlled by a series of guidelines and state-based fertiliser regulations.[198] The environmental soil quality guideline for cadmium in Australia is 3 mg/kg for urban contaminated soils and clearly does not contemplate the protection of food markets.[199] The National Environment Protection (Assessment of Site Contamination) Measure 1999 is made under the National Environment Protection Council Act 1994 (Cth) and is given effect by individual legislation and guidelines in each state and territory.[200] Most Australian states have established a maximum permitted concentration (MPC) for cadmium in phosphate fertilisers of 300 mg cadmium per kg phosphorus.[201]

A National Cadmium Management Committee (NCMC) was established in 2002 and was comprised of representatives from industry, state and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). It was disbanded in 2006 after having achieved all its aims.[202] The Committee oversaw "a strategy to minimise cadmium concentrations and inputs into agricultural soils and crops". It developed a set of best-management practices which were turned into brochures, and certified laboratories considered proficient in the analysis of cadmium in plant samples.[203] A code of practice was developed for the fertiliser industry designed to target "low cadmium fertiliser to those areas/industries which have an existing or potential cadmium problem" such as potato growers. It advised that horticultural crops should be monitored for cadmium, and a national database and geographic information system for cadmium in agricultural produce was created.[204]

195 MJ McLaughlin and others "Effect of potassic and phosphatic fertilizer type, fertilizer Cd concentration and zinc rate on cadmium uptake by potatoes" (1995) 40 Fertilizer Research 63.

196 MJ Bell and others "Inter- and intra-specific variation in accumulation of cadmium by peanut, soybean, and navybean" (1997) 48 Aust J Agric Res 1151.

197 KB Jinadasa and others "Survey of cadmium levels in vegetables and soils of greater Sydney Australia" (1997) 26 J Environ Qual 924.

198 MJ McLaughlin "Heavy metals, the full picture, national, international and local" (Paper presented to Fertilizer Industry Australia conference, 2004) at 2.

199 De Vries and McLaughlin, above n 17, at 248.

200 National Environment Protection Council *National Environment Protection (Assessment of Site Contamination) Measure* (2014) <www.scew.gov.au>.

201 For example, Agricultural and Veterinary Products (Control of Use) Regulations 2004, Part 3, Division 1(9), South Australia.

202 National Cadmium Management Committee *Australian Cadmium Minimisation Strategy* (2014) <www.cadmium-management.org.au>.

203 M Warne and others *Final report of the National Cadmium Management Committee NCMC (2000–2006)* (National Cadmium Management Committee, 30 June 2007) at 6.

204 At 10.

The Committee's final report stated that "the average concentration of cadmium for phosphorous fertilisers sold in Australia is now around 100 mg cadmium/kg phosphorus".[205] A more recent figure in a 2013 study reported an average of 60 mgCd/kgP.[206] These figures show a concerted effort from the fertiliser industry to provide lower-cadmium product, at levels close to that suggested to prevent further cadmium accumulation in soil, despite regulatory levels allowing up to 300 mgCd/kg.[207] This industry buy-in is not reflected in New Zealand where the average levels are reported to be twice the Australian figure at 180 mgCd/kg P.[208]

8. POLICY

This part of the article discusses two of the current policies that can significantly impact on the management of cadmium as a contaminant in New Zealand.

8.1 National Cadmium Management Strategy

The Cadmium Management Strategy is a framework combining governance, research, monitoring and management for cadmium in food, soils and fertilisers.[209] Its objective is: "To ensure that cadmium in rural production poses minimal risks to health, trade, land use flexibility and the environment over the next 100 years."[210]

The Strategy establishes a stakeholder working group — the Cadmium Management Group (CMG) — whose role is to assess and manage the long-term risks to New Zealand's agricultural and food systems from cadmium.[211] This includes a focus on the ongoing monitoring of food, soil and fertiliser. The Strategy recognises that the CMG's "ability to manage risks is constrained by a lack of information in key areas such as the impact of cadmium on the environment and groundwater".[212] The CMG will lead a review of the Strategy in 2017. The Strategy has two broad ambitions for managing the risks:[213]

205 At 6.
206 De Vries and McLaughlin, above n 17, at 256.
207 Ballance Agri-Nutrients "Fact sheet for cadmium" (2005) <www.ballance.co.nz>.
208 Rys, above n 37, at 1.
209 Cadmium Working Group, above n 10, at 1.
210 Rys, above n 37, at 2.
211 Cavanagh and others, above n 169, at 2.
212 Cadmium Working Group, above n 10, at 6.
213 At 6.

- A comprehensive food monitoring programme, which is the means of identifying the risks to trade and human health.
- A soil, water and fertiliser monitoring and fertiliser management programme, which is the primary means addressing the land use flexibility and environmental risks.

The Strategy incorporates the Tiered Fertiliser Management System. This establishes tiered levels of phosphate fertiliser use based on cadmium soil concentrations. The higher the soil concentration, the more stringent the management practices.

This system requires in the first instance testing for cadmium. Farmers appear to have a limited knowledge of cadmium, but "little detailed understanding of associated risks or potential implications of soil Cd accumulation".[214] Some farmers have been reported to view cadmium as a potential threat, and feel that the voluntary testing "introduces cost with few immediate benefits".[215]

The Strategy is a great initiative. However, as long as the solutions remain voluntary, relying on personal relationships with fertiliser suppliers to build the confidence and understanding of individual farmers, and cadmium levels remain mostly unmonitored in soil and food, with no regulation to limit the ongoing contamination, then the levels of cadmium will likely continue to grow.

8.2 Ministry of Primary Industries Export Growth Policy

Current government policies are strongly encouraging and assisting further land-use change and development via investment in irrigation for large areas of rural production land as a means of economic growth. The drawback of the intensification of dairy farming in New Zealand over the last 30 years has been the significant negative impacts on our freshwater systems.[216] Intensification of farming practices has led and will lead to further accumulation of cadmium if the current concentrations of cadmium in our fertiliser, and application rates, continue.

214 Aaron Stafford, Jo-Anne Cavanagh and Ants Roberts "Soil Cadmium — Review of Recent Data in Relation to the Tiered Fertiliser Management System" in LD Currie and CL Christensen (eds) *Nutrient Management for the Farm, Catchment and Community* (Fertilizer and Lime Research Centre, Occasional Report 27, Massey University, 2014) at 7.

215 At 2.

216 Rowan Taylor and Ian Smith *The State of New Zealand's Environment — Chapter Seven: The State of Our Waters* (Ministry for the Environment, 1997) at 6.

MPI has aligned its business strategy[217] with the Government's Business Growth Agenda[218] which includes a goal of doubling New Zealand's primary industry exports by 2025.[219]

The Government has invested in an Irrigation Acceleration Fund which primarily "supports regional rural water harvesting, storage, and distribution infrastructure". Crown Irrigation Investments, a crown entity, was established in 2013 to fund schemes which otherwise would not attract funding.[220] Since 2008 the Government has allocated $112 million in support of rural irrigation projects. It remains the Government's intention to increase this over time to around $400 million.[221] This investment highlights the Government's policy ambitions to use water and soil (and fertiliser) as a major driver of economic growth.

Satellite image of the Mackenzie District illustrates former dryland transformation via recent irrigation.[222]

Much of MPI's policy appears to be heavily influenced by economic modelling commissioned in 2010 by the Ministry of Agriculture and Forestry (MAF now MPI) from an independent body the New Zealand Institute of Economic Research (NZIER).[223] In a 2014 speech given by Minister for Primary Industries Nathan Guy at the Irrigation New Zealand Conference he reinforces

217 Ministry for Primary Industries *Briefing for Incoming Ministers* (Ministry for Primary Industries, 25 January 2013) at 6.

218 The Ministry of Business, Innovation and Employment *The Business Growth Agenda: Progress Report* (2013) <www.mbie.govt.nz>.

219 Nathan Guy "Guy: Speech to Irrigation NZ conference" (8 April 2014) <www.scoop.co.nz>.

220 Crown Irrigation Investments "Homepage" (2015) <www.crownirrigation.co.nz>.

221 Nathan Guy, above n 219.

222 Google Earth screenshot Image of Twizel region in the South Island (January 2015).

223 Bill Kaye-Blake, Chris Schilling and James Zuccollo *The economic impact of increased irrigation: A dynamic Computable General Equilibrium analysis of increased irrigation in*

his statements on the potential of irrigation by quoting the 2010 NZIER findings which "suggests that irrigation has the potential to increase our agricultural exports by over $4 billion annually by 2026".[224]

This policy is highly questionable. This statement is based on a critique of the NZIER report when it was released in 2010 by the Treasury in a confidential briefing paper to the Minister and Associate Minister for Infrastructure. The briefing paper was obtained under the Official Information Act[225] (OIA) in 2013 by the Green Party which has made it available on its website.[226] The Green Party OIA request was framed as seeking "the final versions of all Treasury reports and Aide Memoires provided to the Minister of Finance about the Ruataniwha water storage and irrigation".[227] In this report the Treasury found the NZIER projections were based on questionable modelling of the costs and benefits of potential irrigation investment and that they "could not have a high level of confidence in any of the scheme analyses".[228] It found the basis given for the principal gains to the economy would come from the stimulatory effect of the construction activity on and off farms. Regarding the modelling for farm gate costs and revenue, the Treasury advice was "the information suggests that at the farm gate the costs exceed the benefits".[229] Point 5 on the Treasury's briefing document simply states: "Social and environmental costs have not been considered."

A pertinent comment on the relative values of policy decisions was made in a recent report on the Cadmium Management Strategy which calls for more research for greater understanding as to how best to manage cadmium in soil:[230]

> Funding for the required research remains problematic in an environment where "innovation" and "export growth" are the primary focus for research investment and "defensive investment" to protect and maintain the resources upon which our agricultural economy is based, is viewed less favourably.

Large areas of rural land over the last two decades have been converted from lower-intensity sheep farming and forestry to high-intensity dairying. The result is increasing water pollution from animal effluent and fertiliser runoff into

New Zealand: Final Report to Ministry of Agriculture and Forestry (New Zealand Institute of Economic Research, 9 November 2010).

224 Nathan Guy, above n 219.

225 Official Information Act 1982.

226 Russell Norman "Treasury undermines Govt's business case for irrigation subsidy" (6 November 2013) Green Party <www.home.greens.org.nz>.

227 Green Party OIA request <https://home.greens.org.nz/sites/default/files/irrigation_oia.pdf>.

228 New Zealand Treasury *Potential of irrigation* (New Zealand Treasury report no T2010/2187, 9 November 2010) at [11].

229 At [11].

230 Cavanagh and others, above n 169, at 10.

rivers and streams and water tables.[231] There are clear links between declining national water quality and intensification of land use.[232] Given the state of our freshwater pollution and the requisite increases of phosphate fertiliser use (and resulting cadmium loads) that will result from the Government further driving agricultural expansion, this policy is clearly at odds with the sustainable development of New Zealand's resources.

The Parliamentary Commissioner for the Environment has urged smarter policy responses for the difficult environmental challenges we face:[233]

> it is essential to avoid making trade-offs between environmental and economic objectives if short-term economic benefits later give rise to long-term damage to natural capital and associated costs to society. It is important to redesign social and economic systems if there is evidence that they are encouraging farmers to pursue environmentally unsustainable practices.

New Zealand has much at stake. A 2013 MPI briefing paper states: "'New Zealand' is an internationally valuable brand. We have an international reputation as a credible and trusted supplier of food produced in a clean/green country."[234] Yet without credible sustainable development and management of our natural resources we risk losing much more than our reputation including the food security of future generations.

9. CONCLUSIONS

Contaminating our most productive arable soils is an unsustainable practice at odds with the sustainable management ethic of the RMA. The issues are complex and interact with a variety of Acts and regulations. The RMA provides appropriate scope and delegation to central and local government to better manage the problem of cadmium discharges into production soil and waterways. To date this issue does not appear to have been given the full consideration it deserves. Central government policy has not been developed to guide or control the use of slowly accumulating contaminants on production land and consequently planning controls deal only weakly in general with discharges. Council rules contain little mention of the management of fertiliser

231 Ministry for the Environment "Agriculture and Fresh Water" (18 December 2008) <www.mfe.govt.nz>.

232 Environment Waikato Regional Council *The condition of rural water and soil in the Waikato region: risks and opportunities* (Environment Waikato Regional Council, Hamilton, 2008) at [4].

233 Parliamentary Commissioner for the Environment, above n 8, at 28.

234 Ministry for Primary Industries, above n 217, at 8.

and when they do it is specific to nutrient management. The Food Act puts in place adequate regulation of limits of cadmium in common foods, but is effectively toothless as it has almost no testing or follow-up. The Agricultural Compounds and Veterinary Medicines Act provides for a range of conditions to be imposed to manage the risks associated with agricultural compounds but this has not been invoked in relation to cadmium levels in fertiliser. The same analysis has been applied to the Hazardous Substances and New Organisms Act.

Twenty-first-century farming needs to be brought into line with the actual ecological parameters within which it operates. The verdict of this article is that business as usual is not sustainable. The creation of more and more export commodities now to fuel economic growth will be of little comfort to the generation of New Zealanders that inherits land unfit for food production, rural residential land use, or finds produce unable to be exported because of trading partner restrictions on heavy metal contamination. It is vital we conserve the soil's life-supporting capacity as our basic asset.

Australia appears to have achieved significant cadmium fertiliser reductions without stronger regulation, but New Zealand is nowhere near this position. The Cadmium Management Strategy is an important step in the right direction. However, it suffers from constrained funding for vital further research. It appears much could be done with selecting plant varieties and soil additives to make cadmium bioavailability lower. Further education is essential to gain the understanding and support of farmers. Yet there is a need for regulation of fertiliser cadmium levels and the targeting of a lowest cadmium fertiliser product to those areas with an existing or potential cadmium problem. We need to identify and manage land with higher cadmium levels, and the cadmium status of higher-risk food strains. This can only be achieved if land and crops are tested to identify a baseline. The resulting increases in business expenditure to achieve long-term sustainable farming are seen as reasonable and justifiable regulation.