IN THE HIGH COURT OF NEW ZEALAND
WELLINGTON REGISTRY

CIV-2014-485-4138

UNDER THE	Judicature Amendment Act 1972 and the Declaratory Judgments Act 1908
IN THE MATTER OF	An application for judicial review and an application for a declaration
BETWEEN	NEW HEALTH NEW ZEALAND INC
	Plaintiff
AND	ATTORNEY-GENERAL FOR AND ON BEHALF OF THE MINISTER OF HEALTH
	Defendant

AFFIDAVIT OF PAUL FRANCIS PRENDERGAST ON BEHALF OF THE DEFENDANT

Sworn 7 July 2014

CROWN LAW
TE TARI TURE O TE KARAUNA
PO Box 2858
WELLINGTON 6140
Tel: 04 472 1719
Fax: 04 473 3482

Contact Person:
Jane Foster / Susannah Shaw
Email: Jane.Foster@Crownlaw.govt.nz / Susannah.Shaw@Crownlaw.govt.nz

I, Paul Francis Prendergast, Retired Public Servant now public health engineering contractor of Wellington, sweat:

Introduction

1. From 1999 to October 2010 I was employed as the Principal Public Health Engineer by the Ministry of Health (the Ministry) in Wellington. Following my retirement I am contracted by the Ministry to provide it with public health engineering advice. From 1992 to 1999, I was employed by the Ministry as its Senior Adviser, Public Health Engineering. From 1988 to 1992, I was employed by the Wellington Regional Council as its Water Resources Manager. From 1984 to 1988 I was employed by the then Ministry of Works and Development as its Water Resources Manager in the Water and Soil Directorate.

2. I hold a Bachelor of Engineering (Civil) degree from University of Canterbury. I am a member of the Institution of Professional Engineers NZ, a Registered Engineer from 1977 to 2003 and a Chartered Professional Engineer from 2003 to 2008, and a member of Water New Zealand (Water NZ). Water NZ is the water industry's association and includes membership from water and wastewater suppliers (mainly local government), Crown research institutes and other scientists, several Government departments and equipment manufacturers/suppliers.

3. I have over 30 years' experience in water and wastewater management with both central and local government. I have been on the drinking water standards committee (a committee formed by the Ministry of Health composed of engineering and scientific experts to develop the Drinking-water Standards for NZ) since 1994 and was involved with the writing of the 1995, 2000, 2005, and 2008 versions of the *Drinking-water Standards for New Zealand.* I have also been a member of a number of related Standards NZ committees such as NZS 5826: *Pool Water Quality* and AS/NZS 4020: *Testing of Products for Use in Contact with Drinking Water.*

4. I am authorised to make this affidavit on behalf of the Ministry of Health.

5. I have read, and agree to be bound by, the Code of Conduct for Expert Witnesses set out in Schedule 4 of the New Zealand High Court Rules.

6. In this affidavit I discuss the New Zealand drinking water standards and the role of the Ministry in administering the Health Act 1956 (the Health Act), how water supplies are monitored to ensure the safety of water delivered to the consumer, fluoride and fluoride compounds and how the standards and testing apply to fluoridated water.

Health Act 1956

7. The Ministry administers the Health Act which is the principal legislation governing the control of reticulated drinking water supplies, particularly with regard to the quality and the adequacy of the water supplied.

8. Typically public drinking water supplies are owned by territorial authorities (TAs) such as a district or city council. They extract the source water, run the treatment plant to remove risks or contaminants and pipe the water to consumers.

9. Under the Health Act, the Ministry is responsible for:

   9.1 establishing the drinking-water standards (DWSNZ);

   9.2 maintaining a register of drinking-water supplies; and

   9.3 publishing an *Annual Report on Drinking-water Quality in NZ* (pursuant to section 69ZZZB of the Health Act) which lists all water supplies and their compliance with the DWSNZ for the previous year.

10. The Health Act also requires the Director-General of Health to designate Drinking Water Assessors who approve Water Safety Plans (WSP) that providers of public drinking-water supplies (water suppliers) are required to prepare. The WSP examines the risks to a water supply and how they are to be managed. If fluoride is to be added, the WSP must cover how the fluoride is to be handled and added to the supply and how risks related to adding the fluoride are to be managed.

11. The Ministry also has a number of non-regulatory tools/policies in place to assist in the management of drinking-water supplies such as:

   11.1 grading of drinking-water supplies;

11.2 providing guidelines to industry for drinking-water quality management in New Zealand, eg the Water NZ Guideline *Supply of Fluoride for Use in Water Treatment: May 2014*;

11.3 providing guidelines on preparing WSPs for drinking-water supplies; and

11.4 providing various other publications such as booklets, pamphlets and DVDs to educate and advise the public on their water supplies.

Drinking-water Standards

12. The drinking water standards are the primary tool for ensuring the safety of drinking water. The Health Act requires all public drinking water suppliers "to take all practicable steps to comply with drinking-water standards of New Zealand".

13. The *Drinking-water Standards for New Zealand* (DWSNZ) are compiled by an Expert Committee comprising over 30 of the country's most experienced drinking-water personnel covering a wide range of expertise. The DWSNZ are based on the current version of the World Health Organization's (WHO) *Guidelines for Drinking-water Quality* (available online at www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/index.html). Many Western countries have drinking-water standards based on the WHO Guidelines including the Australian Drinking-water Guidelines which are comparable to the New Zealand Standards and has the same MAV (maximum allowable value) for fluoride (discussed below at paragraph 17 and following). In Australia approximately 90% of population on reticulated supplies receive fluoridated drinking-water.

14. The current version of the DWSNZ is the Drinking Water Standards for New Zealand 2005 (revised 2008) (available online at www.health.govt.nz/publication/drinking-water-standards-new-zealand-2005-revised-2008). A copy of the DWSNZ is attached as exhibit **A**.

15. The DWSNZ use the latest available knowledge about health aspects relating to bacteria, protozoa, cyanotoxins, radiochemicals and chemicals to establish

the standards and the monitoring that is required to demonstrate compliance with the standards.

16. Under the DWSNZ, public water suppliers are expected to test the water regularly to demonstrate compliance. Samples are taken at specified intervals to measure whether certain chemical substances, microbiological organisms or other characteristics (determinands) exceed the maximum allowable value (MAV). Any exceedence of a determinand must be reported immediately to the Drinking-water Assessor and appropriate action taken. The results of all monitoring of supplies serving more than 100 people are reported in the *Annual Report on Drinking-water* (available online at www.health.govt.nz/publication/annual-report-drinking-water-quality-2012-2013).

Maximum allowable value ("MAV")

17. The MAVs apply to any determinand that was in the source water but not fully removed (eg microorganisms, pesticides and industrial wastes), added during the treatment process (eg fluoride and impurities in water treatment chemicals), produced in the distribution system (eg bacteria and disinfection by-products), and arising from the plumbing (eg copper and lead).

18. The MAV of a chemical substance (for example chlorine, fluoride, lead or arsenic) is based on an assessment of the teratogenic (capable of causing birth defects), mutagenic (causing or increasing the frequency of genetic mutations) and carcinogenic (causing or increasing the risk of cancer) properties of the substance, based on a lifetime of consuming the water supply. Also considered in the assessment are effects such as organ failure, behaviour change, metabolic changes, body or organ weight changes, effects on the nervous system, cardiovascular, haematological and blood pressure effects, gastrointestinal effects, and skeletal effects. The assessment covers the likely effects on all organs, and on children, pregnant women, and other susceptible people. Each MAV is derived after estimating the human intake from air, food and water. Most MAVs are very conservative and incorporate a safety factor from 100 to 3000 depending on the level of uncertainty.

19. The MAV of a microbiological organism is its concentration in drinking-water above which there is a significant risk of contracting a waterborne (enteric) disease.

20. The DWSNZ divide all determinands of public health significance into four classes according to the priority with which they should be measured in order to avoid unnecessary monitoring. Only determinands in the Priority 1 and 2 classes require measuring but the others have been defined in case they are required in the future.

Priority 1 determinands

21. The determinands with the highest priority for monitoring, called "Priority 1 determinands" must be measured in all drinking-water supplies. These are micro-organisms which are of public health significance: *E. coli* bacteria and *Giardia* and *Cryptosporidium* protozoa.

22. *E. coli* is measured in order to gain an indication of water contamination by faecal material. If *E. coli* is successfully removed from the water supply other bacteria and viruses will also be eliminated. The amount of monitoring required for *E. coli* is specified in the DWSNZ. In metropolitan areas, such as Auckland and Wellington, samples must be taken daily. In the smallest communities, samples may be taken monthly. In all cases, a minimum of a year's sampling is required to demonstrate compliance with the standards.

23. The successful removal of *Giardia and Cryptosporidium* protozoa is generally indicated by treatment plant processes. Because it is not practical to monitor for protozoa directly, surrogate measurements of the treatment plant processes are used instead which show the plant is operating correctly and therefore removing or disabling protozoa.

Priority 2 determinands

24. Priority 2 determinands are chemical determinands known to have adverse effects upon human health at certain levels. Unlike Priority 1 determinands, they do not have to be measured in every supply. Monitoring is usually required if the Ministry believes, due to evaluation of the water source, surveys or local knowledge, that levels in a particular supply are likely to exceed half the MAV for a particular health-significant determinand.

25. Priority 2 (a or b) determinands are those which may be added by the water supplier during treatment at 50% of the MAV or greater and therefore must be

monitored in accordance with the DWSNZ. These include chlorine and fluoride as discussed below.

26. Compliance is determined by results over a 12 month period of measurement. Therefore, if an individual sample exceeds the MAV it is said to be a "transgression", but may not result in failure to comply with the DWSNZ.

27. The DWSNZ also contain Guideline Values for aesthetic parameters which are based on effects such as taste and odour as reported by the most sensitive people (ie: threshold limits). These are not MAVs and not required to be met to comply with DWSNZ.

Water treatment

28. In the production of drinking water, a number of different chemicals may be added to the water. The types and quantities of chemicals can vary widely and will depend on a range of factors including raw water quality, treatment processes employed and treated water quality objectives. Chemicals used in New Zealand water treatment plants may include aluminium sulphate (alum), calcium hydroxide (hydrated lime), calcium hypochlorite, calcium oxide (quick lime), activated carbon, chlorine, copper sulphate, ferric chloride, ferric sulphate, fluorosilicic acid, hydrofluorosilicic acid, ozone, polyacrylamides, polyaluminium chloride, potassium permanganate, sodium bicarbonate, sodium carbonate, sodium fluoride, sodium fluorosilicate, sodium hydroxide, sodium hypochlorite, sulphuric acid and probably others.

29. Chemical treatment processes are used to:

29.1 control algae;

29.2 remove turbidity and colour;

29.3 remove microorganisms;

29.4 remove algal metabolites and synthetic pollutants;

29.5 reduce organic matter;

29.6 reduce the concentration of iron, manganese and other elements;

29.7 reduce pesticides (note – herbicides are usually included in the broad group of pesticides);

29.8 control taste and odour;

29.9 soften water;

29.10 buffer or modify the pH;

29.11 disinfect; and or

29.12 control corrosion in distribution systems.

30. Chemical treatment may also be used for other public health measures, including fluoridation to reduce the incidence of dental caries. Fluoridation of drinking water is not a treatment process, but has been and continues to be effective in reducing the incidence of dental caries.

31. When used, fluoridation is generally undertaken after clarification and chlorination of the water, because fluoride ions may absorb onto the surface of suspended matter in the water and subsequently be removed through these processes. Fluoridation is generally achieved by adding either a slurry of sodium fluorosilicate, a solution of hydrofluorosilicic acid or, (less commonly) a saturated solution of sodium fluoride, all added as a metered dose for a given rate of water flow.

32. Fluoride feed systems should be installed so that they cannot operate unless water is being produced (interlocked) as one precaution against overdosing. For example, the metering pump should be wired electrically in series with the main well pump or the service pump.

33. When dosing fluoride with hydrofluorosilicic acid or sodium silicofluoride day tanks are also employed as another step to manage the risk of overdosing. This means that if a dosing pump were to malfunction and run too fast it would empty the day tank and then cease dosing. When using a dry feed system to dose sodium silicofluoride loss of weight scales are incorporated to monitor the amount of chemicals used in the dry feeder. These scales measuring weight change, flow meters and other parts of the process (including fluoride concentration by online analysers) are usually continually

monitored online and linked to alarms should they depart from certain set parameters.

Disinfection

34. As stated in the 2011 WHO *Guidelines for Drinking-water Quality* (2011 WHO Guidelines):

> Disinfection is of unquestionable importance in the supply of safe drinking-water. The destruction of microbial pathogens is essential and very commonly involves the use of reactive chemical agents such as chlorine.
>
> Disinfection is an effective barrier to many pathogens (especially bacteria) during drinking-water treatment and should be used for surface waters and for groundwater subject to faecal contamination. Residual disinfection is used to provide a partial safeguard against low-level contamination and growth within the distribution system. (page 5)
>
> The use of chemical disinfectants in water treatment usually results in the formation of chemical by-products. However, the risks to health from these by-products are extremely small in comparison with the risks associated with inadequate disinfection efficacy, and it is important that disinfection not be compromised in attempting to control such by-products (page 6).

35. The above shows that disinfection is the most important treatment, even if very small amounts of undesirable chemical byproducts could be formed. However the DWSNZ also contain MAVs for these disinfection byproducts which must not be exceeded.

36. Coagulation followed by filtration is often called "conventional water treatment" and is commonly used throughout New Zealand to remove the natural organic matter that may interact with the disinfectant.

37. As the 2011 WHO Guidelines state at page 56 "The most commonly used disinfection process is chlorination. Ozonation, UV irradiation, chloramination and application of chlorine dioxide are also used."

38. The 2011 WHO Guidelines and the DWSNZ have established standards (GV or MAV) to regulate the concentration of disinfection by-products to safe levels.

39. The maximum acceptable value (MAV) for chlorine in drinking-water in New Zealand is 5 mg/L. Due to the treatment processes used in New Zealand no water supply contains more than 2.5 mg/L of chlorine, very few exceed 1 mg/L, and it is not common to find a water supply with more than 0.5 mg/L.

Health Act as it applies to drinking-water and the addition of fluoride

40. The addition of fluoride during the treatment process is a Priority 2 (a or b) determinand and must be monitored with any exceedences reported and the situation corrected as soon as possible. Most water treatment plants will have online fluoride monitoring so that the levels are continuously checked and connected to an alarm if a set value is exceeded (as explained above at paragraph 33). For compliance with the DWSNZ, a sample is required to be taken weekly in the reticulation and analysed by an approved laboratory.

41. In May 2014 Water NZ published its latest guideline *Supply of Fluoride for Use in Water Treatment*, which replaces the 1997 version. This Guideline was prepared for Water NZ and the Ministry of Health. A copy of the Guideline is attached as exhibit **B.** The Guideline sets out the allowable levels of impurities in the supplied fluoride. The levels of impurities in fluoride are therefore controlled and the maximum that they can contribute to the treated drinking-water is known. Any impurities (such as lead) from all sources also have set MAVs in the drinking-water standards for which the Priority 2 monitoring programme can control to ensure that no chemical determinand in the treated drinking-water will exceed its MAV.

What is fluoride?

42. The element fluorine belongs to the group of elements commonly known as the halogens. They are grouped because they share many properties. The other halogens are chlorine, bromine and iodine. Fluorine and chlorine are very reactive gases and are not found naturally. They react with water to form the halides fluoride and chloride, which can form salts with some metals, eg sodium. Sodium chloride is called common salt.

43. When sodium salts dissolve in water, the sodium and the chloride or fluoride ionise, that is, they separate and move freely in the water. So do other ions such as potassium, magnesium, sulphate and bicarbonate. A chloride ion or a fluoride ion is always the same, regardless of where it came from. For

example, the chloride in sodium chloride is exactly the same as the chloride in calcium chloride, magnesium chloride, potassium chloride etc. If they were not the same they would be called something different.

44. Sodium fluorosilicate acid and/or hydrofluorosilic acid are hazardous substances under the Hazardous Substances and New Organisms Act 1996 and accordingly this Act regulates if they can be imported, whether the intrinsic properties can be modified and how they are transported and stored. Page 7 of the Water NZ Guideline refers suppliers to other regulations for transport and safety they must comply with, including under the Health and Safety in Employment Act 1992, the Land Transport Act 1998 and the Resource Management Act 1991.

45. Larger water suppliers in New Zealand that fluoridate their supplies typically use hydrofluorosilicic acid because it is less costly than imported sodium fluorosilicate, with sodium fluoride being the most expensive option. Hydrofluorosilicic acid is manufactured in New Zealand as a co-product of the superphosphate industry. The imported phosphate rock used to produce superphosphate fertiliser contains approximately 4% fluoride. This fluoride comes from the bones and teeth of ancient fish that are components of the phosphate rock. The fluoride found in the bones and teeth of fish comes from the sea, which has a fluoride concentration of around 1.4 mg/L (parts per million).

Maximum Acceptable Value for fluoride

46. The maximum acceptable value (MAV) for fluoride of 1.5 mg/L was set in the 1984 DWSNZ and has remained unchanged for 30 years. It was based on the WHO Guideline, first edition (1984). The WHO guideline value has also remained unchanged. The MAV is health-based and covers a lifetime of consuming 2 litres a day. The MAV is based on a value to ensure long term usage does not result in mild mottling of teeth, that is for cosmetic purposes.

47. This health-based value of 1.5 mg/L has also been adopted in many countries, including Australia and Great Britain. The United States equivalent to the New Zealand MAV called the maximum contaminant level (MCL) is set at a much higher level for fluoride - 4 mg/L. This is because the United States has large areas dependant on groundwater supplies which have naturally occurring

higher fluoride content. Fluoride is very difficult to remove and the United States has set a less precautionary MAV/MCL than WHO or ourselves. This means the United States is prepared to accept a higher degree of mottling of teeth than many other countries as these populations have always been exposed to this level of fluoride.

48. The results of drinking-water sampling by all water suppliers for compliance with the DWSNZ are held in the Ministry of Health drinking-water database which is managed and operated for the Ministry by ESR Ltd. Over the last seven years, a total of 21,279 fluoride samples have been analysed in approved laboratories. Thirteen of these samples were recorded as transgressions (ie exceeding the MAV of 1.5 mg/L) with the highest recorded value being 2.12 mg/L (this compares with the United States EPA allowable value of 4 mg/L).

Heavy metals in fluoride compounds

49. It is exceedingly difficult and very unusual to produce any chemical that is "100% pure".

50. The source chemicals for fluoride (sodium fluoride, sodium silicofluoride and hydrofluorosilicic acid) will inevitably contain very small amounts of impurities including heavy metals.

51. The Water NZ Guideline on the supply of fluoride chemicals uses the term "specific impurity limits" (SIL) to cover all metallic determinands that have MAVs assigned to them in the DWSNZ. They are antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, selenium and uranium. The specific impurity limits (SIL) for these metals in commercially available hydrofluorosilicic acid, sodium fluoride and sodium silicofluoride are given in Appendix A2 of the Standard. The Appendix shows how the SILs were calculated.

52. The SIL calculation is based on the MAV for each metal; the maximum fluoride dose rate; the purity of the product; and a safety factor of 10. The maximum fluoride dose rate used is 1 mg/L. In reality, most water suppliers will dose closer to 0.7 mg/L, so the safety factor is nearer about 14. Therefore