ACUTE MAXIMUM ACCEPTABLE VALUES FOR CHEMICAL DETERMINANDS OF HEALTH SIGNFICANCE

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PREPARED BY: Peter Cressey, Risk and Response Group

REVIEWED BY: Dr Jefferson Fowles, Tox-Logic

Peer reviewer	Peer reviewer	Project Manager
		
Dr Jefferson Fowles	**Dr Chris Nokes**	**Peter Cressey**
Tox-Logic	Science Leader, Risk and Response Group	Senior Scientist, Risk and Response group

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EXECUTIVE SUMMARY

The *Drinking Water Standards for New Zealand 2005 (Revised 2008)* specify maximum acceptable values (MAVs) for chemical contaminants (determinands) that may be present in New Zealand drinking-water supplies. With the exception of cyanide, nitrate and nitrite and some cyanotoxins, MAVs are based on chronic toxicological endpoints and are intended to provide protection based on lifelong exposure. On occasions, the concentration of chemical determinands in drinking-water supplies may exceed the associated MAV for a short period of time (days to several weeks). Currently, there are no New Zealand guidelines on levels of chemical determinands that may be acceptable for short-term exceedances of the MAV.

The current report presents acute MAVs (aMAVs; 1 and 10 day and intermediate) for the majority of the chemical determinands included in the *Drinking Water Standards for New Zealand 2005 (Revised 2008)*. The largest proportion of these aMAVs are adopted directly from the USEPA's health advisories (HAs and human health benchmarks for pesticides), which have been developed specifically for guiding advice on short-term exposure to elevated concentrations of chemical determinands.

A further set of aMAVs were defined using health-based guidance values (HBGVs) specifically derived for less-than-lifetime exposures (acute reference doses, acute and intermediate minimum risk levels). Such HBGVs provide a suitably robust basis for aMAVs.

In the absence of any short-term HBGVs, aMAVs have been developed by recalculating the current MAVs with 100% allocation of the underlying HBGV to drinking-water. This approach is contingent on:

- The HBGV underlying the MAV being relevant to short-term exposures, and
- Known New Zealand dietary exposures to the determinands not being at a level that accounts for a major proportion of the HBGV.

In most cases aMAVs calculated from the MAV are conservative.[1]

Derivation of aMAVs was not possible for all determinands and/or all short-term durations. In such cases the MAV will continue to be the limit value for determining the significance of water contamination incidents.

[1] In this report 'conservative' has the meaning usually applied in risk assessment and refers to assumptions that will tend to inflate the assessment of risk, to provide an extra margin of safety.

GLOSSARY OF ACRONYMS AND TERMS

Acute toxicity	1. *Adverse effects* of finite duration occurring within a short time (up to 14 days) after administration of a single *dose* (or *exposure* to a given *concentration*) of a test substance or after multiple doses (exposures), usually within 24 hours of a starting point (which may be exposure to the *toxicant*, or loss of reserve capacity, or developmental change, etc.) 2. Ability of a substance to cause *adverse effects* within a short time of dosing or *exposure*
ADI	Acceptable daily intake. The amount of a substance in food or drinking water, normally expressed on a body weight basis, that can be ingested (orally) on a daily basis over a lifetime without an appreciable health risk, on the basis of current knowledge
Adverse effect	A change in biochemistry, physiology, growth, development morphology, behaviour, or lifespan of an organism which results in impairment of functional capacity or impairment of capacity to compensate for additional stress or increase in susceptibility to other environmental influences
ARfD	Acute reference dose. An estimate of the amount of a substance in food and/or drinking-water, normally expressed on a body weight basis, that can be ingested in a period of 24 hours or less, without appreciable risk to the health of the consumer, on the basis of current knowledge
Benchmark response (BMR)	A specified change in biological response compared to background. For example, a 10% increase in the number of animals developing fatty liver compared with untreated animals
Dermal	Cutaneous, pertaining to the skin
Dose	Total amount of a substance administered to, taken up, or absorbed by an organism, organ, or tissue
Dose response	Association between dose and the incidence of a defined biological effect in an exposed population
Dose response assessment	Analysis of the relationship between the total amount of an agent administered to, taken up by, or absorbed by an organism, system, or (sub)population and the changes developed in that organism, system, or (sub)population in reaction to that agent, and inferences derived from such an analysis with respect to the entire population. Dose–response assessment is the second of four steps in risk assessment
Exposure assessment	Evaluation of the exposure of an organism, system, or (sub)population to an agent (and its derivatives). Exposure assessment is the third step in the process of risk assessment
HA	Health advisory. An estimate of acceptable drinking water levels for a chemical substance based on health effects information, for a specified exposure duration
HBGV	Health-based guidance value. Any exposure value, such as an ADI, which specifies a safe or tolerable level of human exposure to a chemical substance

Harm	An adverse effect. Damage or adverse effect to a population, species, individual organism, organ, tissue, or cell
Hazard identification	The identification of the type and nature of adverse effects that an agent has an inherent capacity to cause in an organism, system, or (sub)population. Hazard identification is first of four steps in risk assessment
HHBP	Human health benchmarks for pesticides, developed by the US Environmental Protection Agency (USEPA). An estimate of acceptable drinking water levels for acute (one-day), chronic (non-cancer), and carcinogenic effects (10^{-6} – 10^{-4} risk level) to protect against adverse health effects from exposure to pesticides that may be found in drinking-water
LOAEL	Lowest observed adverse effects level. Lowest concentration or amount of a substance, found by experiment or observation, that causes alterations of morphology, functional capacity, growth, development, or life span of target organisms distinguishable from those observed in normal (control) organisms of the same species and strain under the same defined conditions of exposure
Margin of exposure (MOE)	Ratio between a defined point on the dose-response curve (eg. NOAEL) for the adverse effect and the estimated human exposure
MAV	Maximum acceptable value. The highest concentration of a determinand in the water that, on the basis of present knowledge, is considered not to cause any significant risk to the health of the consumer over 70 years of consumption of that water
NOAEL	No observed adverse effects level. Greatest concentration or amount of a substance, found by experiment or observation, that causes no alterations of morphology, functional capacity, growth, development, or life span of target organisms distinguishable from those observed in normal (control) organisms of the same species and strain under the same defined conditions of exposure
Oral	Pertaining to or via the mouth
Point of departure	A dose level used to quantify risk
Risk assessment	The process of estimating the nature and probability of adverse health effects in humans who may be exposed to hazards in environmental media, now or in the future. Risk assessment includes four components; hazard identification, hazard characterisation (dose-response), exposure assessment and risk characterisation
Risk characterisation	The qualitative and, wherever possible, quantitative determination, including attendant uncertainties, of the probability of occurrence of known and potential adverse effects of an agent in a given organism, system, or (sub)population, under defined exposure conditions. Risk characterisation is the fourth step in the risk assessment process
TDI	Tolerable daily intake. The amount of a substance that can be ingested, to which it is believed that a person can be exposed daily over a lifetime without deleterious effect. The TDI is analogous to the ADI, but is defined for substances that are incidentally present in food and/or drinking-water, rather than having been intentionally added or applied

Toxicological endpoints	An observable or measurable biological event or chemical concentration (e.g. metabolite concentration in a target tissue) used as an index of an effect of a chemical exposure

1. INTRODUCTION

The *Drinking Water Standards for New Zealand 2005 (Revised 2008)* (DWSNZ 2005) specify maximum acceptable values (MAVs) for chemical contaminants (determinands) that may be present in New Zealand drinking-water supplies[2] (MoH 2008). The DWSNZ 2005 defines the MAV of a chemical determinand in drinking-water as

> 'the highest concentration of a determinand in the water that, on the basis of present knowledge, is considered not to cause any significant risk to the health of the consumer over 70 years of consumption of that water. Wherever possible, the MAVs have been based on the latest WHO guideline values. The WHO used a body weight of 60 kg to calculate its guideline values, but in the DWSNZ the MAVs are based on a body weight of 70 kg to better represent the average weight of New Zealand adults. MAVs are applicable to all categories of drinking-water'.

With the exception of copper, cyanide, nitrate and nitrite and some cyanotoxins, MAVs are based on chronic toxicological endpoints and are intended to provide protection based on lifelong exposure. On occasions, the concentration of chemical determinands in drinking-water supplies may exceed the associated MAV for a short period of time (days to several weeks). Currently, there are no New Zealand guidelines on levels of chemical determinands that may be acceptable for short-term exceedances of the MAV.

The current project establishes a set of guideline values for concentrations of determinands in drinking water that are considered acceptable for short periods of time, to be known as acute MAVs (aMAVs).

[2] Changes to the MAVs requires an update to the DWSNZ which in turn is governed by the Health Act 1956. Section 69P of the Health Act 1956 requires consultation before any amendments are made to the DWSNZ.

2. EXISTING SOURCES OF AMAVS

2.1 WORLD HEALTH ORGANIZATION

The World Health Organization (WHO) in the publication *Guidelines for Drinking-water Quality* (WHO 2011) include the following guidance for assessing short-term exposures:

> 'Health-based values for short-term exposures can be derived for any chemicals that are used in significant quantities and are frequently involved in an emergency as a consequence of spills, usually to surface water sources. JMPR has provided guidance on the setting of acute reference doses (ARfDs) for pesticides (Solecki et al 2005). These ARfDs can be used as a basis for deriving short-term health-based values for pesticides in drinking-water, and the general guidance can also be applied to derive ARfDs for other chemicals.
>
> The ARfD can be defined as the amount of a chemical, normally expressed on a body weight basis that can be ingested in a period of 24 hours or less without appreciable health risk to the consumer. Most of the scientific concepts applicable to the setting of ADIs or TDIs for chronic exposure apply equally to the setting of ARfDs.
>
> The toxicological end-points most relevant for a single or 1-day exposure should be selected. For ARfDs for pesticides, possible relevant end-points include haematotoxicity (including methaemoglobin formation), immunotoxicity, acute neurotoxicity, liver and kidney toxicity (observed in single-dose studies or early in repeated-dose studies), endocrine effects and developmental effects. The most relevant or adequate study in which these end-points have been determined (in the most sensitive species or most vulnerable subgroup) is selected, and NOAELs are established. The most relevant end-point providing the lowest NOAEL is then used in the derivation of the ARfD. Uncertainty factors are used to extrapolate from experimental animal data to the average human and to allow for variation in sensitivity within the human population.
>
> An ARfD derived in such a manner can then be used to establish a health-based value by allocating 100% of the ARfD to drinking-water.
>
> Available data sets do not allow the accurate evaluation of the acute toxicity for a number of compounds of interest. If appropriate single-dose or short-term data are lacking, an end-point from a repeated-dose toxicity study can be used. This is likely to be a more conservative approach, and this should be clearly stated in the health-based value derivation. When a substance has been spilt into a drinking-water source, contamination may be present for a period longer than 24 hours, but not usually longer than a few days. Under these circumstances, the use of data from repeated-dose toxicity studies is appropriate. As the period of exposure used in these studies will often be much longer than a few days, this, too, is likely to be a conservative approach.
>
> Where there is a need for a rapid response and suitable data are not available to establish an ARfD (for ARfDs established by JMPR, see http://www.who.int/ipcs/food/jmpr/en/index.html; for short-term drinking-water health advisories for contaminants in drinking-water produced by the United States Environmental Protection Agency, see http://www.epa.gov/waterscience/criteria/drinking/), but a guideline value is available for the chemical of concern, a simple pragmatic approach would be to allocate a higher proportion of the ADI or TDI to drinking-water. As the ADI or TDI is intended to be protective of lifetime exposure, small exceedances of the ADI or TDI for short

periods will not be of significant concern for health. It would therefore be possible to allow 100% of the ADI or TDI to come from drinking-water for a short period.'

However, despite providing this guidance, WHO have not derived aMAVs or equivalent short-term determinand concentration guidelines.

2.2 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

2.2.1 Health Advisories

In addition to maximum concentration levels (MCLs; equivalent to MAVs), the United States Environmental Protection Agency (USEPA) have derived guideline concentrations for chemical determinands for less than lifetime periods of exposure (USEPA 1987; 2012). These guideline values are known as health advisories (HAs) and are defined as:

> 'An estimate of acceptable drinking water levels for a chemical substance based on health effects information; an HA is not a legally enforceable Federal standard, but serves as technical guidance to assist Federal, State, and local officials.
>
> **One-Day HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to one day of exposure. The One-Day HA is intended to protect a 10-kg child consuming 1 liter of water per day.
>
> **Ten-Day HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to ten days of exposure. The Ten-Day HA is also intended to protect a 10-kg child consuming 1 liter of water per day.
>
> **Lifetime HA:** The concentration of a chemical in drinking water that is not expected to cause any adverse **noncarcinogenic effects** for a lifetime of exposure, incorporating a drinking water RSC[3] factor of contaminant-specific data or a default of 20% of total exposure from all sources. The Lifetime HA is based on exposure of a 70-kg adult consuming 2 liters of water per day. For Lifetime HAs developed for drinking water contaminants before the Lifetime HA policy change to develop Lifetime HAs for all drinking water contaminants regardless of carcinogenicity status in this DWSHA update, the Lifetime HA for Group C carcinogens, as indicated by the 1986 Cancer Guidelines, includes an uncertainty adjustment factor of 10 for possible carcinogenicity'.

For the purpose of the current project, the one-day and ten-day HAs are of primary interest.

2.2.2 Human Health Benchmarks for Pesticides

Human Health Benchmarks for Pesticides (HHBPs) have been developed by USEPA using the same methodology used to derive HAs and utilising reference doses (RfDs) and/or cancer slope factors (CSFs) derived from health effects data during the pesticide registration process (USEPA 2013). HHBPs have been developed

> 'for acute (one-day), chronic (non-cancer), and carcinogenic effects (10^{-6} – 10^{-4} risk level) to protect against adverse health effects from exposure to pesticides that may be found in surface or ground water used for drinking. The HHBP table lists the acute as well as chronic RfD, the noncancer benchmarks for the sensitive

[3] Relative source contribution. The proportion of total exposure that is attributed to a specific exposure source.

population/lifestage and, when appropriate, the CSF and the corresponding carcinogenic benchmarks. The acute reference doses (aRfD) are usually determined for children, general population or females of reproductive age'.

For the purpose of the current project, the one-day HHBPs are of primary interest.

2.2.3 Acute Reference Doses

Where appropriate, the USEPA Office of Pesticide Programs (OPP) may derive an acute reference dose (ARfD), as part of the risk assessment process for registration or re-registration of a pesticide product (USEPA 2000; 2002a). The ARfD is defined as:

> 'An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure for an acute duration (24 hours or less) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used'.

In the absence of other data sources, ARfDs may be useful in determining aMAVs and are the basis for the acute HHBPs derived by USEPA (USEPA 2016).

USEPA may also derive Population Adjusted Doses (PADs) for either acute or chronic durations. The PAD is derived from the associated RfD or ARfD by adjusted to account for the Food Quality Protection Act (FQPA) Safety Factor (SF). This calculation is performed for each population subgroup. The FQPA SF is intended to provide an additional 10-fold safety factor, to protect for special sensitivity in infants and children to specific pesticide residues or to compensate for an incomplete database.

2.3 AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency of the US Department of Health and Human Services. ATSDR 'serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances'. As part of their assessment of toxic substance, ATSDR will seek to define minimal risk levels (MRLs) (ATSDR 2016). MRLs are defined as 'an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure'.

MRLs are derived for acute (1-14 days), intermediate (>14-364 days), and chronic (365 days and longer) exposure durations, and for the oral and inhalation routes of exposure. For the current project, acute and intermediate MRLs (aMRL and iMRL) may be used to calculate aMAVs, in a manner similar to that used to calculate HHBPs from ARfDs.

2.4 JOINT FAO/WHO EXPERT COMMITTEE ON FOOD ADDITIVES

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) is an international scientific expert committee administered jointly by the Food and Agriculture Organization of the United Nations (FAO) and WHO. JECFA evaluates the safety of food additives, contaminants, naturally occurring toxicants and residues of veterinary drugs in food. If there are acute toxicological concerns associated with the substance under evaluation and appropriate toxicological information is available an ARfD may be derived (FAO/WHO 2009). JECFA define the ARfD as 'an estimate of the amount of the substance in food and/or drinking-water, normally expressed on a body weight basis, that can be ingested in a period of 24 hours or less, without appreciable risk to the health of the consumer, on the basis of all the known facts at the time of the evaluation'.

2.5 JOINT FAO/WHO MEETING ON PESTICIDE RESIDUES

The Joint FAO/WHO Meeting on Pesticide Residues (JMPR) is an international scientific expert committee administered jointly by the FAO and WHO. JMPR evaluates the safety of residues of pesticides in food. If there are acute toxicological concerns associated with the substance under evaluation and appropriate toxicological information is available an ARfD may be derived (FAO/WHO 2009). JMPR define the ARfD as 'an estimate of the amount of the substance in food and/or drinking-water, normally expressed on a body weight basis, that can be ingested in a period of 24 hours or less, without appreciable risk to the health of the consumer, on the basis of all the known facts at the time of the evaluation'.

2.6 EUROPEAN FOOD SAFETY AUTHORITY

The European Food Safety Authority (EFSA) is a European agency funded by the European Union that was set up in 2002, following a series of food crises in the late 1990s, to be a source of scientific advice and communication on risks associated with the food chain. EFSA may occasionally define an ARfD for a substance under evaluation, although this is usually only done for pesticides. EFSA defines an ARfD as 'an estimated intake of a chemical substance in food, expressed on a bodyweight basis, that can be ingested over a short period of time, usually during one meal or one day, without posing a health risk'.

2.7 AUSTRALIAN DEPARTMENT OF HEALTH

The Australian Department of Health's Office of Chemical Safety (OCS) develops and maintains ADIs and ARfDs for agricultural and veterinary chemicals (OCS 2016a; 2016b). In some cases OCS adopted ARfDs set by JMPR for use in Australia, but in other instances ARfDs are derived specifically for Australia.

3. APPROACH USED TO DERIVE AMAVS FOR NEW ZEALAND

3.1 CONSIDERATIONS

3.1.1 Toxicological endpoints

The majority of the current New Zealand MAVs are for chronic exposure and therefore are based on chronic end-points in toxicological studies. The aMAVs derived in the current project are ideally based on short-term toxicological endpoints. WHO have suggested that appropriate endpoints for the evaluation of acute toxicity will include haematotoxicity (including methaemoglobin formation), immunotoxicity, acute neurotoxicity, liver and kidney toxicity (observed in single-dose studies or early in repeated-dose studies), endocrine effects and developmental effects (WHO 2011).

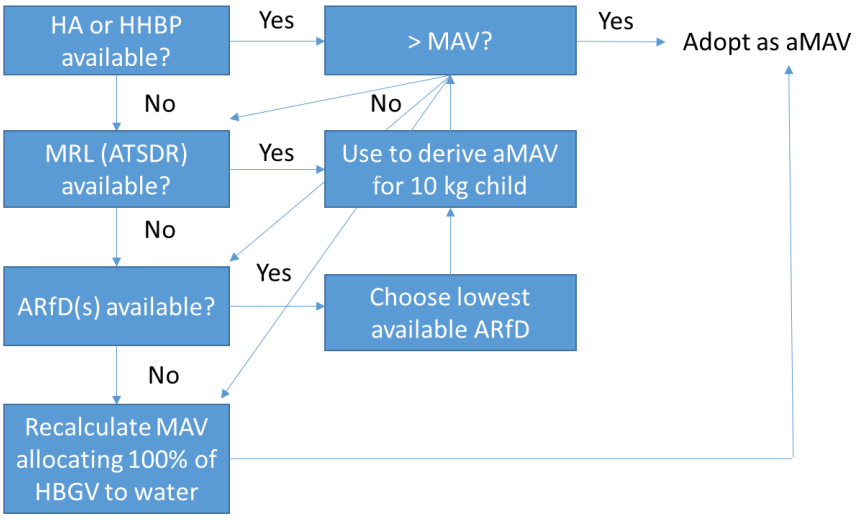
3.1.2 Population group

MAVs are defined to provide protection for a lifetime of exposure. The majority of the lifetime is lived as an adult and the mechanism for calculating MAV concentrations from health-based exposure guidelines involves adult body weight (70 kg) and adult drinking-water consumption (2 L/day) (MoH 2008). For short-term exposure to elevated levels of chemical determinands, aMAVs should be protective of the most vulnerable consumers. This is likely to be post-weaning children, usually referred to as toddlers (1-3 years), as their intake of drinking-water, on a body weight basis, is high, while some of the mechanisms for metabolic detoxification are immature. This is consistent with the approach taken by USEPA in defining HAs and HHBPs, with guidance values for the concentration of the substance in water defined in terms of a 10 kg child, ingesting one litre of water per day (USEPA 2012; 2013). It is also consistent with the approach used by USEPA in their derivation of PADs (see section 2.2.3 is this report).

3.2 APPROACH

Figure 1 provides a flowchart of the approach used to derive aMAVs for chemical determinands for which MAVs are defined in the DWSNZ 2005 (MoH 2008).

Figure 1. Flowchart for derivation of aMAVs for New Zealand drinking-water chemical determinands



For ARfDs and for recalculation of the MAV the toxicological studies underlying the reference value were considered. Usually the summaries of the toxicological studies included in the regulatory assessments were considered, but where possible original toxicological study reports were also consulted. ARfDs may be based on effects seen after administration of a single dose or may be based on effects seen after repeated doses for periods as long as 3-6 months. The duration of the study underlying the ARfD will affect the duration of any aMAV derived from it. While MAVs are usually derived from HBGVs based on adverse health effects in chronic animal studies, in many cases the same toxicological effects seen in long-term studies are also seen in short-term studies. In such cases it is reasonable to use a MAV to define an aMAV. If the toxicological endpoints observed in short-term and long-term studies of the chemical are quite different then an aMAV was only derived from the MAV if exposure to the determinand from other sources, such as the diet, is likely to be negligible. For example, if short-term studies show adverse haematological effects, while long-term studies show effects on development of the organism, then the MAV isn't strictly relevant to short-term toxicity. In such cases, the value derived from the MAV is not a true aMAV, as it is not based on acute toxic effects, but may still be a useful guidance value for assessing short-term exceedances of the MAV.

Where an aMAV is defined from a MAV, by recalculation with 100% allocation of the HBGV to drinking-water, available New Zealand information on dietary exposure to the substance was reviewed. If dietary exposure to the substance already exhausts a substantial proportion of the HBGV, then allocation of 100% of the HBGV to drinking-water, even for a short time period was considered to be inappropriate. For example, if chronic dietary exposure to a chemical already accounted for 50% of the HBGV, allowing a further 100% of the HBGV from drinking-water would place an unwanted toxicological burden on the consuming population.

The project scope specified derivation of aMAVs for short (14 days or less) or intermediate (15-364 days) periods of time. These are the definitions used by ATSDR for their aMRL and iMRL. However, due to the structure of the data sources being used, aMAVs are reported for:

- 1-day. Based on 1-day HAs or HHBPs or ARfDs derived from single exposure studies or current MAVs, with allocation of 100% of the HBGV to drinking-water.
- Short-term. Based on 10-day HAs or HHBPs or aMRLs or ARfDs derived from repeated dose animal studies of one day up to one week duration or current MAVs, with allocation of 100% of the HBGV to drinking-water.
- Intermediate-term (sub-chronic). Based on iMRLs or ARfDs derived from repeated dose animal studies of between seven and 90 days duration, or current MAVs, with allocation of 100% of the HBGV to drinking-water.

Where appropriate bases for deriving 1 or 10-day aMAVs are not available, aMAVs for intermediate duration exposure are presented as 'conservative' estimates of the short-term aMAV. In this context, calculating an aMAV from the current MAV is the approach of last resort and the resulting aMAV was applied across all durations of interest. It should be noted that aMAVs derived from existing MAV were only recalculated with respect to the proportion of the HBGV assigned to drinking-water (100%, rather than the usual 10-20%). Such aMAVs are still based on a 70 kg adult ingesting 2 L/day of drinking-water, rather than a 10 kg child ingesting 1 L/day of drinking-water.

4. RESULTS

Table 1 summarised aMAVs for 1 and 10 days and intermediate duration (up to one year) for chemical determinands included in the DWSNZ. Where the derivation of the aMAV is self-explanatory, for example, when the aMAV is adopted directly from a USEPA HA, no further explanation is provided. For determinands where the derived aMAVs require further substantiation, explanations are included in the following section. **For chemicals and durations where no aMAV has been derived, this reflects that there is currently no basis for a limit other than the existing MAV.**

Of the 115 individual chemical determinands included in the DWSNZ, a complete set of aMAVs (1-day, 10-day and intermediate) were able to be derived for 44 determinands (38%). For a further 41 determinands (36%) a basis was found to derive or adopt 1- and 10-day aMAVs, but not intermediate duration aMAVs.

4.1 EXPLANATION FOR THE DERIVATION OF SPECIFIC AMAVS

Anatoxin-a. No HAs or MRLs have been defined for anatoxin-a. USEPA reviewed the toxicological data on anatoxin-a in 2015 and concluded that the data are currently inadequate to derive a HA (USEPA 2015). The TDI that the current New Zealand MAV is derived from is based on acute agonist effects on neuronal nicotinic acetylcholine receptors, affecting electrical transmission between nerve cells (MoH 2016). Given the sub-chronic nature of this study, the current MAV, with 100% allocation to drinking-water, was used to derive an aMAV for 1 and 10 day and intermediate durations. It should be noted that the resulting aMAV is likely to be conservative for 1 and 10-day periods.

Antimony. HAs (1 and 10-day) were defined for antimony in 1992 (0.01 mg/L), but are lower than the current New Zealand MAV (0.02 mg/L) (USEPA 2012). It should be noted that the pivotal study used by USEPA has since been extensively reviewed and several points of criticism identified (Lynch et al 1999). The TDI that the current New Zealand MAV (and WHO guideline value) is derived from is based on decreased body weight gain and reduced food and water intake in a 90-day study in rats (Poon et al 1998). Given the sub-chronic nature of this study, the current MAV, with 100% allocation to drinking-water, was calculated as an aMAV for 1 and 10 day and intermediate durations. It should be noted that the resulting aMAV is likely to be conservative for 1 and 10-day periods.

Carbofuran. USEPA derived HAs for 1- and 10 day and longer-term exposure durations of 0.05 mg/L in 1987 (USEPA 1987). However, these HAs do not appear in their 2012 collation (USEPA 2012). JMPR derived an ARfD of 0.009 mg/kg bw in 2002, based in reversible inhibition of plasma and erythrocyte cholinesterase in a 4-week dog study (JMPR 2002). More recently, EFSA derived an ARfD of 0.00015 mg/kg bw, based on a new study showing inhibition of brain acetylcholinesterase in rat pups. No NOAEL was found in this study and an extra uncertainty factor of two was applied for extrapolation from the LOAEL. Using the lowest ARfD as the HBGV to derive an aMAV for a 1 kg child ingesting 1 L/day drinking-water, with 100% allocation of the HBGV to drinking water, gives an aMAV of 0.0015 mg/L. This is lower than the current New Zealand MAV and no specific aMAVs were adopted for this determinand.

Chlorate. No HAs or MRLs have been defined for chlorate. The TDI that the current New Zealand MAV is derived from is based on thyroid gland colloid depletion in a 90-day study in rats. Given the sub-chronic nature of this study, the current MAV, with 100% allocation to drinking-water, was calculated as an aMAV for 1 and 10 day and intermediate durations. It

should be noted that the resulting aMAV is likely to be conservative for 1 and 10-day periods.

Chlorite. HAs (1 and 10-day) have been defined for chlorite (0.8 mg/L), but are the same as the current New Zealand MAV (0.8 mg/L) (USEPA 2012). ATSDR have derived an oral iMRL (0.1 mg/kg bw/day), equating to an intermediate aMAV of 1 mg/L for a 10 kg child ingesting 1 L/day of drinking-water, with 100% allocation of the iMRL to drinking-water (ATSDR 2016). This aMAV was applied for 1 and 10 day durations. It should be noted that the resulting aMAV is likely to be conservative for 1 and 10-day periods.

Chlorotoluron. Chlorotoluron has not been used in and is not currently registered for use in New Zealand. A TDI for chlorotoluron (11.3 μg/kg bw/day) has been derived by WHO, based on reduction in body weight, a slight increase in white blood cell count, increased plasma urea levels, an increase in the activity of alkaline phosphatase in females, and a statistically significant reduction in the mean relative kidney weights in both sexes in a 2-year mouse feeding study (WHO 2003f). Similar findings (slight decrease in body weight in both genders, increased incidence of splenic haemosiderosis and Kupffer's cell activity in the liver, slight reversible increases in haemoglobin concentration, erythrocyte counts, and haematocrit values in females, and transient increases in serum alkaline phosphatase activity) were found in a short-term (3 month) feeding study in rats, with a NOAEL of 52 mg/kg bw/day. For the short-term study, applying an uncertainty factor of 1000 (100 for interspecies and intraspecies variability and a further 10 for deficiencies in the database) gives an HBGV of 0.05 mg/kg bw/day. The aMAV derived by applying this HBGV for a 10 kg child ingesting 1 L/day of drinking-water, with 100% allocation to water (0.5 mg/L) is essentially the same as recalculating the current MAV with 100% allocation to water (0.4 mg/L). Chlorotoluron was not detected in any foods analysed as part of the 2009 New Zealand Total Diet Study (NZTDS) and exposure to chlorotoluron from the diet is likely to be minimal (Vannoort and Thomson 2011). The lower value was adopted as the aMAV for 1-day, 10-days and intermediate periods. It should be noted that EFSA determined that derivation of an ARfD for chlorotoluron was unnecessary and the 1- and 10-day aMAVs determined above should be considered to be conservative (EFSA 2011b).

Chlorpyriphos. USEPA has derived 1 and 10-day HAs for chlorpyriphos (0.03 mg/L) (USEPA 2012). However, these HAs are slightly less than the current New Zealand MAV (0.04 mg/L). EFSA derived an ARfD of 0.005 mg/kg bw, based on single dose red blood cell cholinesterase inhibition in rats (EFSA 2014b). JMPR have derived a substantially higher ARfD (0.1 mg/kg bw), based on single dose erythrocyte cholinesterase inhibition in humans (JMPR 1999). Given that the JMPR ARfD is derived from human observations, this HBGV is preferred for the current exercise. It should be noted that the Australian OCS ARfD is the same as the JMPR ARfD (OCS 2016a). For a 10 kg child ingesting 1 L/day of drinking-water, with 100% allocation of the ARfD to drinking-water this equates to an aMAV of 1 mg/L, but applicable only to 1-day exposures. While the ADI (0.01 mg/kg bw/day) that the New Zealand MAV is based on was derived from long-term rat studies, the effects seen are the same as those seen in short-term studies: cholinesterase inhibition. Therefore, a short-term aMAV was derived from the existing MAV by allocating 100% of the ADI to water (0.4 mg/L) and was adopted for 10-day and intermediate durations. Dietary exposure to chlorpyriphos in New Zealand has been estimated to be 0.02-0.05% of the ADI, depending on the population group considered (Vannoort and Thomson 2011).

2,4-DB. The TDI (30 μg/kg bw/day) that the New Zealand MAV for 2,4-DB (0.1 mg/L) was based on is based on the NOAEL for effects on body and organ weights, blood chemistry, and haematological parameters in a 2-year rat study (WHO 2003c). A similar NOAEL was determined in a 7-week study in beagle dogs, with similar toxicological effects seen. Given the similarity in long- and short-term toxicological effects due to 2,4-DB, a short-term

estimate of aMAV was derived from the existing MAV by allocating 100% of the ADI to water. Given that there is no evidence of dietary exposure to 2,4-DB in New Zealand (Vannoort and Thomson 2005), the aMAV is proposed for 1-, 10-day and intermediate periods.

Di(2-ethylhexyl) phthalate (DEHP). The current MAV is based on a NOAEL of 2.5 mg/kg bw/day in a 7 day rat study, for liver peroxisome proliferation (WHO 2003b). The diet is the main source of exposure to DEHP and the current MAV is based on a 1% allocation of the TDI to drinking-water. ATSDR derived an iMRL of 0.1 mg/kg bw/day, equating to an intermediate aMAV of 1 mg/L for a 10 kg child ingesting 1 L/day of drinking-water, with 100% allocation of the iMRL to drinking-water (ATSDR 2016). This value was adopted as the aMAV for 1- and 10-day exposure periods, but is likely to be conservative for these shorter time periods.

Dibromoacetonitrile. The current New Zealand MAV was based on a NOAEL in a 90-day rat study (WHO 2004) and was the lowest NOAEL for short-term studies with durations of 14 to 90 days. The MAV is based on a 20% allocation of the TDI to drinking-water. However, given that the haloacetonitriles are water disinfection by-products, this allocation seems very conservative. As the MAV already accounts for short-term toxicity, aMAVs (1- and 10-days and intermediate duration) were derived from the current MAV by allocating 100% of the MAV to drinking-water.

Dichloroacetonitrile. The current New Zealand MAV was based on a NOAEL in a 90-day rat study (WHO 2004) and was the lowest NOAEL for short-term studies with durations of 14 to 90 days. The MAV is based on a 20% allocation of the TDI to drinking-water. However, given that the haloacetonitriles are water disinfection by-products, this allocation seems very conservative. As the MAV already accounts for short-term toxicity, aMAVs (1- and 10-days and intermediate duration) were derived from the current MAV by allocating 100% of the MAV to drinking-water.

Dichlorprop. The TDI for dichlorprop (36 μg/kg bw/day) was based on renal toxicity in a 2-year rat feeding study (WHO 2003c). Renal toxicity was also seen in sub-chronic studies and a NOAEL of 12.4 mg/kg bw/day was reported for slight liver hypertrophy in a single 90-day rat study. This NOAEL can be used to calculate a short-term HBGV by applying a 1000 fold uncertainty factor (100 for interspecies and intraspecies extrapolation and 10 for database deficiencies) to give a HBGV of 12 μg/kg bw/day. Calculating an aMAV from this HBGV for a 10 kg child ingesting 1 L/day of drinking-water, with 100% allocation of the HBGV to drinking-water results in an aMAV of 0.12 mg/L. Deriving an aMAV from the existing MAV, by recalculating with 100% allocation of the TDI to drinking-water, results in a slightly lower aMAV (0.1 mg/L). Dichlorprop was not detected in any foods analysed as part of the 2003/2004 NZTDS and dietary exposure is likely to be negligible (Vannoort and Thomson 2005). The lower value (0.1 mg/L) is proposed as the aMAV for 1-, 10-day and intermediate time periods.

EDTA. The current New Zealand MAV is based on an ADI derived by JECFA based on a 2-year[4] reproductive toxicity study in rats (JECFA 1974). It should be noted that the NOAEL was the highest dose included in the study, in other words, no effects were seen at any dose

[4] The initial parental group were terminated after 2 years. They had two litters, the progeny from which were also included in the feeding trial and had two litters. This study design was intended to give animals with a range of exposure durations after 2 years total study time.

level. No suitable studies are available to derive a NOAEL for short-term exposure to EDTA (WHO 2003j).The current MAV is based on a 1% allocation of the TDI to drinking-water, with the majority of exposure likely to be from food consumption (WHO 2011). On this basis, it appears inappropriate to derive aMAVs by allocating 100% of the TDI to drinking-water. However, allocation of 10% of the TDI to drinking-water for a short period of time (1- to 10-days) does not seen unreasonable. The allocation of 10% of the TDI was chosen as an intermediate magnitude between the current 1% applied for derivation of MAV and 100%, taking into account that the majority of exposure will be from the food supply.

Fenoprop. Fenoprop is not currently registered for use in New Zealand, but has been in the past. The current New Zealand MAV for fenoprop is based on a TDI (0.003 mg/kg bw/day), based on liver effects in a 2-year dog study (WHO 2003c). Liver damage was also seen in short-term (90-day) dog studies. Given the consistency of toxicological findings across study durations, aMAVs (1 and 10 day and intermediate) were calculated from the current MAV by allocating 100% of the TDI to drinking-water (0.1 mg/L). There is no information available on the prevalence of fenoprop in the New Zealand food supply (Vannoort and Thomson 2005; Vannoort and Thomson 2011). The aMAVs for 1- and 10-days are likely to be conservative.

Isoproturon. Equivalent NOAELs were derived from both a short-term (90-day) study in beagle dogs and a long-term toxicological study in rats (WHO 2003a). Therefore the derived TDI (3 μg/kg bw/day) should be equally applicable to intermediate- and long-term exposure to isoproturon. The current MAV is based on 10% allocation of the TDI to drinking-water (WHO 2011). Isoproturon was not detected in any foods analysed in the 2003/2004 NZTDS and dietary exposure is likely to be negligible (Vannoort and Thomson 2005). As the MAV already accounts for short-term toxicity, aMAVs (intermediate) were derived from the current MAV by allocating 100% of the MAV to drinking-water (0.1 mg/L). EFSA has derived an ARfD of 0.1 mg/kg bw/day, based on haematological effects in a short-term dog study (EFSA 2015). Based on a 10 kg child ingesting 1 L/day of drinking-water and allocating 100% of the ARfD to drinking-water gives an aMAV of 1 mg/L. This was adopted as a 1- and 10-day aMAV for New Zealand.

Mecoprop. The current New Zealand MAV for mecoprop (0.01 mg/L) is based on a TDI derived from effects on kidney weight in 1- and 2-year rat studies (WHO 2003c). In short-term studies (90 days to seven months) in rats and beagle dogs, consistent NOAELs of 3-4 mg/kg bw/day were found with haematological effects seen in all studies. Given the consistency of toxicological findings an uncertainty factor of 100 was applied to the lower NOAEL of 3 mg/kg bw/day to give a short-term HBGV of 0.03 mg/kg bw/day. The Australian OCS derived a substantially higher ARfD of 0.5 mg/kg bw, based on maternal and foetal toxicity in a rat developmental study (OCS 2016a). Based on a 10 kg child ingesting 1 L/day of drinking-water and allocating 100% of the TDI to drinking-water gives an aMAV, based on this ARfD, of 5 mg/L. It should be noted that EFSA decided there was no need to derive an ARfD (EFSA 2013a). The derived aMAV was adopted for 1- and 10-day exposure periods.

Metalaxyl. WHO have not developed a guideline value for metalaxyl (WHO 2011) and the current New Zealand MAV is based on a NOAEL of 3 mg/kg bw/day (MoH 2016) used to set an ADI for Australia (Office of Chemical Safety 2016). The NOAEL relates to increases in liver weight in a 2-year rat study. However, essentially the same toxicological effects (changes in relative liver and adrenal weights, without associated histopathology) were seen in a sub-chronic study in beagle dogs (6 months) (JMPR 1983). Therefore, it was considered appropriate to propose the current MAV with 100% allocation to drinking-water as an estimate of intermediate duration aMAV. New Zealand dietary exposure estimates for metalaxyl are in the range 0.003-0.014% of the ADI (Vannoort and Thomson 2011). EFSA

have set an ARfD of 0.5 mg/kg bw/day, based on doses that caused maternal and foetotoxicity in a developmental toxicity study (EFSA 2016b). Based on a 10 kg child ingesting 1 L/day of drinking-water and allocating 100% of the ARfD to drinking-water gives an aMAV of 5 mg/L. This value was adopted for 1- and 10-day aMAVs.

Molinate. The current New Zealand MAV (0.007 mg/L) is derived from a TDI (2 μg/kg bw/day) based on the NOAEL for reduced litter and offspring numbers in a two-year reproductive toxicity study in rats (WHO 2003d). The duration of this study means it is not suitable for deriving aMAVs. Three 90-day studies are available for molinate; two in rats and one in dogs. The lowest NOAEL was 8 mg/kg bw/day in one of the rat studies, with increased organ weights (adrenals, thyroid, testes and kidneys) being the main adverse effect seen. Applying an uncertainty factor of 300 (100 for interspecies and intraspecies extrapolation and 3 for database deficiencies) results in a short-term HBGV of approximately 30 μg/kg bw/day. For a 10 kg child ingesting 1 L/day of drinking-water and with 100% allocation of the HBGV to drinking-water results in an aMAV of 0.3 mg/L. EFSA have derived an ARfD for molinate of 0.1 mg/kg bw/day, based on effects on sperm morphology in a rat study (EFSA 2013b). Based on a 10 kg child ingesting 1 L/day of drinking-water and allocating 100% of the ARfD to drinking-water gives an aMAV of 1 mg/L. This value was adopted for 1- and 10-day aMAVs, while 0.3 mg/L in proposed as an intermediate duration aMAV.

Nitrilotriacetic acid. The MAV for nitrilotriacetic acid (0.2 mg/L) is based on a TDI (10 μg/kg bw/day) derived from the NOAEL (10 mg/kg bw/day) for nephritis and nephrosis in a 2-year rat feeding study (WHO 2003e). While only one short-term toxicological study has been reported, the kidneys were also the target organ, with damage being ‘dose-dependent and rapidly induced’. While no NOAEL was reported for the short-term study, the fact that the damage caused by nitrilotriacetic acid is consistent across term periods suggests that the MAV, with 100% allocation of the TDI to water, is an appropriate surrogate for the aMAV and was applied as a 1- and 10-day and intermediate duration aMAV.

Oxadiazon. This herbicide has not been assigned a guideline value by WHO (WHO 2011). The New Zealand MAV is based on the Australian ADI of 0.05 mg/kg bw/day (MoH 2016; Office of Chemical Safety 2016). It should be noted that the study used to derive this ADI is not reported by the Australian Office of Chemical Safety (Office of Chemical Safety 2016). It should also be noted that the RfD, derived by USEPA, and the ADI derived by EFSA (EFSA 2010) are an order of magnitude lower than the Australian ADI. EFSA have also derived an ARfD for oxadiazon of 0.12 mg/kg bw, based on the NOAEL for foetal death in a rat developmental toxicity study (EFSA 2010). For a 10 kg child with 100% allocation of the ARfD to drinking-water, this equates to an aMAV of 1.2 mg/L. As the ARfD was derived from a repeated dose study, this aMAV was adopted for 1- and 10-day exposures. The current MAV with 100% allocation to drinking-water (2 mg/L) results in a value greater than the aMAV derived from the EFSA ARfD. Oxadiazon was not detected in any food analysed in the 2009 NZTDS (Vannoort and Thomson 2011). No intermediate duration aMAV was adopted for New Zealand.

Pendimethalin. The current aMAV (0.02 mg/L) for pendimethalin is based on a TDI derived from the LOAEL for liver toxicity in a 2-year rat study (WHO 2003g). EFSA have derived an ARfD of 0.3 mg/kg bw/day, based on rib and vertebrae abnormalities in offspring in a rabbit developmental toxicity study (EFSA 2016a). For a 10 kg child with 100% allocation of the ARfD to drinking-water, this equates to an aMAV of 3 mg/L. As the ARfD was derived from a repeated dose study, this aMAV is proposed for 1- and 10-day exposures. The current MAV, with 100% allocation to drinking-water (0.2 mg/L), was adopted as an intermediate duration

aMAV. Pendimethalin was not detected in any food analysed in the 2009 NZTDS (Vannoort and Thomson 2011).

Primisulfuron-methyl. This herbicide has not been assigned a guideline value by WHO (WHO 2011) and the current New Zealand MAV (0.9 mg/L) is based on a RfD of 0.25 mg/kg bw/day derived by USEPA, based on haematological, liver and thyroid effects in a chronic dog study (USEPA 2002b). The USEPA assessment also defined NOAELs for short-term (1-30 days) and intermediate-term (1-6 months) incidental oral exposure of 50 and 25 mg/kg bw/day, respectively, with a level of concern below a margin of exposure of 100. For a 10 kg child ingesting 1 L/day of drinking-water with 100% allocation to drinking-water this suggests aMAVs of 5 and 2.5 for short- and intermediate-term incidental exposure, respectively. These were adopted as aMAVs for New Zealand, with the short-term aMAV covering 1- and 10-day exposure periods.

Propazine. No guideline value for propazine has been derived by WHO (WHO 2011) and the current New Zealand MAV is based on an USEPA RfD of 0.02 mg/kg bw/day (MoH 2016). USEPA have also derived an ARfD for propazine of 0.1 mg/kg bw/day, based on developmental effects in a sub-chronic rat study (USEPA 2006a). Given the subchronic duration of the pivotal study, the ARfD was used as the basis for deriving 1-, 10-day and intermediate duration aMAVs for New Zealand. For a 10 kg child ingesting 1 L/day of drinking-water with 100% allocation to drinking-water this equates to an aMAV of 1 mg/L. Propazine was not detected in any food analysed in the 2009 NZTDS (Vannoort and Thomson 2011).

Pyriproxifen. No guideline value for pyriproxifen has been derived by WHO, although it has been classified as a WHO-recommended compound for control of mosquito larvae in container habitats (WHO 2011). The current MAV is based on the ADI derived by JMPR (JMPR 1999) which is based on liver effects in two 1-year dog studies. JMPR considered that derivation of an ARfD was unnecessary, but noted that 'In short- and long-term studies of the effects of pyriproxyfen in mice, rats, and dogs, the liver was the main toxicological target'. In their peer review of the pesticide risk assessment for pyriproxyfen, EFSA concluded that, 'based on the low toxicity profile of pyriproxifen, the derivation of an Acute Reference Dose (ARfD) was not considered necessary' (EFSA 2009b). Given the low acute toxicity of pyriproxyfen and the similarity in short and long-term toxicity, the current New Zealand MAV (0.4 mg/L), with 100% allocation to water, was used for 1- and 10-day and intermediate duration aMAVs. Pyriproxifen was not detected in any food analysed in the 2009 NZTDS (Vannoort and Thomson 2011).

Saxitoxins. No HAs or MRLs for saxitoxins have been derived. EFSA have derived an ARfD of 0.0005 mg saxitoxin equivalents/kg body weight, based on reports of human intoxications (EFSA 2009a). For a 10 kg child with 100% allocation to drinking-water this suggests an aMAV of 0.005 mg/L. This value was adopted as the aMAV for 1- and 10-day duration periods.

Simazine. The current New Zealand MAV is derived from a TDI based on body weight changes, haematological effects and mammary tumours in a 2-year rat study (WHO 2003h). In the Registration Eligibility Decision (RED) for simazine, USEPA derived an ARfD of 0.3 mg/kg bw/day for reproductive age females (13-49 years), based on increased incidence of unossified teeth, head, vertebrae, sternabrae and rudimentary ribs in a developmental toxicity study (USEPA 2006b). USEPA also defined levels of concern for short and intermediate term incidental oral exposure based on NOAELs of 6.25 and 1.8 mg/kg bw/day, respectively, with levels of concern at margins of exposure less than 300. This implies short

and medium term health based guidance values of 0.021 and 0.006 mg/kg bw/day. Simazine has not been assessed by JMPR or EFSA. Simazine was not detected in any food analysed in the 2009 NZTDS (Vannoort and Thomson 2011). For a 10 kg child ingesting 1 L/day of drinking-water with 100% allocation to drinking-water the USEPA reference doses equate to 3, 0.2 and 0.06 mg/L and these were adopted as 1-, 10-day and intermediate duration aMAVs for New Zealand.

Terbuthylazine. The current New Zealand MAV is derived from a TDI based on decreased body weight gain in a 2-year rat study (WHO 2003i). Terbuthylazine has not been assessed by USEPA or JMPR. EFSA derived an ARfD of 0.008 mg/kg bw, based on maternal toxicity in a rabbit developmental toxicity study (EFSA 2011a). For a 10 kg child with 100% allocation to water this suggests an aMAV of 0.08 mg/L. This is the same value obtained by recalculating the current MAV with 100% allocation to drinking-water. This value was adopted as the aMAV for 1- and 10-day and intermediate durations. Terbuthylazine was not detected in any food analysed in the 2009 NZTDS (Vannoort and Thomson 2011).

Thiabendazole. No short-term HA or HHBP has been defined for thiabendazole. Both JMPR and EFSA have derived ARfDs for thiabendazole (EFSA 2014a; JMPR 2008). EFSA derived an ARfD of 0.1 mg/kg bw/day, which was the same as the acceptable daily intake derived for the same substance. JMPR derived the same ADI and initially the same ARfD. However, at their 2006 meeting JMPR reviewed information from studies specifically designed to support derivation of an ARfD. JMPR derived an ARfD of 0.3 mg/kg bw/day for women of childbearing age, based on maternal toxicity and developmental effects in a mouse developmental toxicity study, and 1 mg/kg bw/day for the general population, based on single dose toxicity studies in rats. It should be noted that using USEPA parameters for women of childbearing age (66 kg, 2 L/day drinking-water intake) and young children (10 kg, 1 L/day drinking-water intake), the two JMPR ARfDs equate to near identical aMAVs (9.9 and 10 mg/L). Given that the ARfD for the general population was based on a single-dose toxicity study, 10 mg/L was adopted as the 1-day aMAV for New Zealand. aMAVs for 10-day and intermediate exposure periods were derived from the more conservative EFSA ARfD for a 10 kg child with 100% allocation to drinking-water (1 mg/L).

Trichloroethene (trichloroethylene). No HA has been defined for trichloroethene. ATSDR have derived an intermediate duration oral MRL of 0.0005 mg/kg bw/day (ATSDR 2016). The intermediate duration MRL is the same as the chronic duration MRL/RfD, based on dose-modelling for both heart malformations in rats and decreased thymus weights in mice (ATSDR 2014). However, derivation of an intermediate duration aMAV based on this MRL (10 kg child, 1 L/day drinking-water intake, 100% allocation to drinking-water) would result in an aMAV (0.005 mg/L) lower than the current New Zealand MAV (0.02 mg/L). The current MAV is based on 50% allocation of the TDI (0.0015 μg/kg bw/day) to drinking-water. The TDI was also based on dose-modelling of foetal heart malformations in a rat developmental toxicity study (WHO 2005). Short-term studies mainly show effects on the liver and kidneys. WHO concluded that exposure to trichloroethene would be from water (drinking, bathing, volatilisation) and the diet. Given that no information is available on dietary exposure to trichloroethene in New Zealand, it is not appropriate to recalculate the current MAV to give an aMAV.

1080 (sodium monofluoroacetate or sodium fluoroacetate). No HA or HHBP has been defined for 1080. 1080 has not been assessed by JMPR or EFSA. Several HBGVs have been derived for 1080, with some variation between them. USEPA have reported a RfD for 1080 of 0.02 μg/kg bw/day, based on a 13-week subchronic oral rat study (USEPA 1995). Foronda et al. used a benchmark dose approach to derive a TDI with a very similar

numerical value (0.03 μg/kg bw/day), based on myocardial and testicular effects in animal studies (Foronda et al 2007). The current New Zealand MAV was derived using a NOAEL of 0.1 mg/kg bw/day, from a teratology study on rats (Eason et al 1999), and an uncertainty factor of 500. This implies a HBGV of 0.0002 mg/kg bw/day (MoH 2016). 1080 is highly acutely toxic and the effects seen in many of the toxicity studies are seen within a short timeframe. The teratology study used as the basis for the current New Zealand MAV involved administration of 1080 to pregnant rats during days 6 to 17 of gestation. On this basis, there is a good argument for applying the current New Zealand MAV across all exposure durations. As concerns relate to women of child-bearing age, the MAV was not recalculated in terms of a 10 kg child.

Table 1. Proposed aMAVs for chemical determinands in the DWSNZ 2005 (revised 2008)

Determinand	Current MAV (mg/L)	Proposed aMAVs (mg/L)					
		1-day	Note(s)	Short-term (10-day)	Note(s)	Intermediate-term	Note(s)
Antimony	0.02	0.2	1,9	0.2	1,9	0.2	9
Arsenic	0.01	0.05	4	0.05	4		
Barium	0.7	2	1, 12	2	1, 12	2	4
Boron	1.4	3	2	3	2	2	4
Bromate	0.01	0.2	2				
Cadmium	0.004	0.04	2	0.04	2	0.005	4
Chlorate	0.8	1	9	1	9	1	9
Chlorine	5		1		1		
Chlorite	0.8	1	12	1	12	1	4
Chromium	0.05	1	2	1	2	0.05	4
Copper	2		1		1		1
Cyanide	0.6		1		1		1
Cyanogen chloride	0.4		1		1		
Fluoride	1.5						
Lead	0.01						
Manganese	0.4	1	2	1	2		
Mercury	0.007	0.07	1,9	0.07	1,9		
Molybdenum	0.07	0.08	2	0.08	2		
Monochloramine	3						
Nickel	0.08	1	2	1	2		
Nitrate	50	440	2,5	440	2,5		1
Nitrite, long-term	0.2					1	4

Determinand	Current MAV (mg/L)	Proposed aMAVs (mg/L)					
		1-day	Note(s)	Short-term (10-day)	Note(s)	Intermediate-term	Note(s)
Nitrite, short-term	3	33	2,5	33	2,5		
Selenium	0.01						
Uranium	0.02		1		1		1
Acrylamide	0.0005	1.5	2	0.3	2	0.01	4
Alachlor	0.02	0.1	2	0.1	2		
Aldicarb	0.01		1		1		
Aldrin + dieldrin	0.00004	0.0003	2,10	0.0003	2,10		6
Anatoxin-a	0.006	0.0075	9	0.0075	9	0.0075	9
Anatoxin-a(s)	0.001		14		14		14
Atrazine	0.002	0.1	4	0.1	4	0.03	4
Azinphos-methyl	0.004	0.03	3				
Benzene	0.01	0.2	2	0.2	2		
Benzo(a)pyrene	0.0007						
Bromacil	0.4	5	2	5	2		
Bromodichloromethane	0.06	1	2	0.6	2		
Bromoform	0.1	5	2	0.2	2		
Carbofuran	0.008		1,11		1,11		
Carbon tetrachloride	0.005	4	2	0.2	2	0.07	4
Chlordane	0.0002	0.06	2	0.06	2	0.006	4
Chloroform	0.4	4	2	4	2	1	4
Chlorotoluron	0.04	0.4	9	0.4	9	0.4	9
Chlorpyriphos	0.04	1	11	0.4	1, 9	0.4	1,9
Cyanazine	0.0007	0.1	2	0.1	2		
Cylindrospermopsin	0.001			0.003	13		
2,4-D	0.04	1	2	0.3	2		
2,4-DB	0.1	1	9	1	9	1	9
DDT + isomers	0.001	0.005	4	0.005	4	0.005	4
Di(2-ethylhexyl)phthalate	0.009	1	4	1	4	1	4

Determinand	Current MAV (mg/L)	Proposed aMAVs (mg/L)					
		1-day	Note(s)	Short-term (10-day)	Note(s)	Intermediate-term	Note(s)
1,2-dibromo-3-chloropropane	0.001	0.2	2	0.05	2	0.02	4
Dibromoacetonitrile	0.08	0.4	9	0.4	9	0.4	9
Dibromochloromethane	0.15	0.6	2	0.6	2		
1,2-dibromoethane (ethylene dibromide)	0.0004	0.008	2	0.008	2		
Dichloroacetic acid	0.05	3	2	3	2		
Dichloroacetonitrile	0.02	0.1	9	0.1	9	0.1	9
1,2-dichlorobenzene	1.5	9	2	9	2	6	4
1,4-dichlorobenzene	0.4	11	2	11	2	0.7	4
1,2-dichloroethane	0.03	0.7	2	0.7	2		6
1,2-dichloroethene	0.06	4	2,7	2	2,7	2	4, 7
Dichloromethane	0.02	10	2	2	2		
1,2-dichloropropane	0.05			0.09	2		6
1,3-dichloropropene	0.02	0.03	2	0.03	2		6
Dichlorprop	0.1	1	9	1	9	1	9
Dimethoate	0.008	0.13	3				
1,4-dioxane	0.05	4	2	0.4	2		6
Diuron	0.02	1	2	1	2		
EDTA (edetic acid)	0.7	7	9	7	9		
Endrin	0.001	0.02	2	0.005	2		6
Epichlorohydrin	0.0005	0.1	2	0.1	2		
Ethylbenzene	0.3	30	2	3	2		6
Fenoprop	0.01	0.1	9	0.1	9	0.1	9
Hexachlorobutadiene	0.0007	0.3	2	0.3	2	0.002	4
Hexazinone	0.4	3	2	2	2		
Homoanatoxin-a	0.002		15		15		15
Isoproturon	0.01	1	11	1	11	0.1	9
Lindane	0.002	1	2	1	2	0.03	2
MCPA	0.002	0.1	2	0.1	2		
Mecoprop	0.01	5	11	5	11		

Determinand	Current MAV (mg/L)	Proposed aMAVs (mg/L)					
		1-day	Note(s)	Short-term (10-day)	Note(s)	Intermediate-term	Note(s)
Metalaxyl	0.1	5	11	5	11	1	9
Methoxychlor	0.02	0.05	2	0.05	2	0.05	4
Metolachlor	0.01	2	2	2	2		
Metribuzin	0.07	5	2	5	2		
Microcystins	0.001			0.0016	13		
Molinate	0.007	1	11	1	11	0.3	17
Monochloroacetic acid	0.02	0.2	2	0.2	2		
Nitrilotriacetic acid	0.2	0.4	9	0.4	9	0.4	9
Nodularin	0.001			0.0016	16		
Oryzalin	0.4	8.25	3,8				
Oxadiazon	0.2	1.2	11	1.2	11		
Pendimethalin	0.02	3	11	3	11	0.2	9
Pentachlorophenol	0.009	1	2	0.3	2	0.01	4
Picloram	0.2	20	2	20	2		
Pirimiphos-methyl	0.1	0.15	3				
Primisulfuron methyl	0.9	5	18	5	18	2.5	18
Procymidone	0.7	1.2	3,8				
Propazine	0.07	1	11	1	11	1	11
Pyriproxifen	0.4	4	9	4	9	4	9
Saxitoxins	0.003	0.005	11	0.005	11		
Simazine	0.002	3	11	0.2	18	0.06	18
Styrene	0.03	20	2	2	2		
2,4,5-T	0.01	0.8	2	0.8	2		
Terbacil	0.04	0.3	2	0.3	2		
Terbuthylazine	0.008	0.08	9,11	0.08	9,11	0.08	9,11
Tetrachloroethene	0.05	2	2	2	2	0.08	4
Thiabendazole	0.4	10	11	1	11	1	11
Toluene	0.8	20	2	2	2	2	4
Trichloroacetic acid	0.2	3	2	3	2		
Trichloroethene	0.02						1

Determinand	Current MAV (mg/L)	Proposed aMAVs (mg/L)					
		1-day	Note(s)	Short-term (10-day)	Note(s)	Intermediate-term	Note(s)
2,4,6-trichlorophenol	0.2		1		1		
Triclopyr	0.1	1.65	3,8				
Trifluralin	0.03	0.08	2	0.08	2		
Vinyl chloride	0.0003	3	2	3	2		
Xylenes	0.6	40	2	40	2	4	4
1080	0.0035	0.0035	15	0.0035	15	0.0035	15

Notes:

(1) Available or derived aMAV, from HA, HHBP or MRL, lower than or equal to current MAV

(2) HA

(3) HHBP

(4) Derived from aMRL or iMRL using 10 kg body weight and 1 L/day drinking-water ingestion

(5) HAs were expressed in terms of N and have been recalculated in terms of NO_3

(6) The calculated intermediate-term aMAV is greater than the acute and/or short-term aMAVs and has not been reported

(7) The substance exists as two isomeric forms, with different HAs. The lower of the two available HAs is reported here

(8) Calculated for females aged 13-49 years

(9) Current MAV recalculated with 100% allocation of the HBGV to drinking-water

(10) aMAV is the lower of the HAs for the chemicals included in this classification

(11) Derived from ARfD

(12) Information available to derive intermediate duration aMAV (iMRL), but not 1- or 10-day. Intermediate duration aMAV proposed as conservative estimate of 1- and 10-day aMAVs

(13) HAs were issued separately for pre-school age children and the school age to adult population. Values here are for the general population. HAs for pre-school age children are below the current New Zealand MAV.

(14) The current MAV is based on the analytical limit of detection, with the calculated MAV about five-fold lower. There is no basis for aMAVs at values above the analytical limit of detection.

(15) The current MAV is already based on an acute toxicological endpoint

(16) The current New Zealand MAV for nodularin was based on similarities in the toxicity of nodularin to microcystins. For consistency, the USEPA HA derived for microcystins is also proposed for nodularin.

(17) Derived from NOAELs for sub-chronic toxicity studies.

(18) Derived from USEPA short and intermediate duration levels of concern

5. CONCLUSIONS

Acute MAVs (1 and 10 day and intermediate) have been proposed for the majority of the chemical determinands included in the *Drinking Water Standards for New Zealand 2005 (Revised 2008)* (DWSNZ 2005). The largest proportion of these aMAVs are adopted directly from the USEPA's HAs (and HHBPs), which have been developed specifically for guiding advice on short-term exposure to elevated concentrations of chemical determinands.

A further set of aMAVs were defined using HBGVs specifically derived for less-than-lifetime exposures (ARfDs, aMRLs, iMRLs). Such HBGVs provide a suitably robust basis for aMAVs.

In the absence of any short-term HBGVs, aMAVs were developed by recalculating the current MAVs with 100% allocation of the underlying HBGV to drinking-water. This approach is contingent on:

- The HBGV underlying the MAV being relevant to short-term exposures, and
- Known New Zealand dietary exposures to the determinands not being at a level that accounts for a major proportion of the HBGV.

In most cases aMAVs calculated from the MAV will be conservative.

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INSTITUTE OF ENVIRONMENTAL SCIENCE AND RESEARCH LIMITED

Kenepuru Science Centre
34 Kenepuru Drive, Kenepuru, Porirua 5022
PO Box 50348, Porirua 5240
New Zealand
T: +64 4 914 0700 **F:** +64 4 914 0770

Mt Albert Science Centre
120 Mt Albert Road, Sandringham, Auckland 1025
Private Bag 92021, Auckland 1142
New Zealand
T: +64 9 815 3670 **F:** +64 9 849 6046

NCBID – Wallaceville
66 Ward Street, Wallaceville, Upper Hutt 5018
PO Box 40158, Upper Hutt 5140
New Zealand
T: +64 4 529 0600 **F:** +64 4 529 0601

Christchurch Science Centre
27 Creyke Road, Ilam, Christchurch 8041
PO Box 29181, Christchurch 8540
New Zealand
T: +64 3 351 6019 **F:** +64 3 351 0010

www.esr.cri.nz