Determination 2015/056[1]

Regarding the code-compliance of asphalt roof shingles to roofs where the rainwater is harvested and used as potable water

Summary

This determination discusses the approaches used in two different test methodologies for products that are used in contact with drinking-water. The determination considered whether there is evidence currently available that would indicate whether asphalt[2] shingles used as part of a rainwater harvesting system will leach contaminants or particulates to an extent that would make the collected water unsuitable for human consumption (non-potable).

1. The matter to be determined

1.1 This is a determination under Part 3 Subpart 1 of the *Building Act 2004*[3] ("the Act") made under due authorisation by me, John Gardiner, Manager Determinations and Assurance, Ministry of Business, Innovation and Employment ("the Ministry"), for and on behalf of the Chief Executive of the Ministry.

1.2 The parties to the determinations are:

- The party who applied for the determination is Auckland Council ("the authority"), carrying out its duties as a territorial authority or building consent authority
- The Ministry of Health has also been included as a party to the matter under section 176(g) of the Act.

1.3 I consider the following to be persons with an interest in the matter:

- four suppliers of asphalt shingles in New Zealand (herein referred to as "supplier A", "supplier B", "supplier C" and "supplier D"), and
- The Building Research Association of New Zealand ("BRANZ")[4].

1.4 I have also provided a copy of this determination to the Ministry for Primary Industries, as the Ministry responsible for the administration of the *Food Act.*

1.5 The authority has applied for a determination on whether asphalt shingles are suitable for use in situations where rainwater is to be harvested from a roof and used as potable water. The authority is concerned that asphalt shingles may leach chemicals and particulates that, if consumed, may be potentially harmful to human

[1] Subject to a clarification under section 189 of the Building Act 2004
[2] Also described as Bituminous roofing shingles
[3] The Building Act, Building Code, compliance documents, past determinations and guidance documents issued by the Ministry are all available at www.building.govt.nz or by contacting the Ministry on 0800 242 243.
[4] BRANZ is an independent and impartial research, testing, consulting and information company providing resources for the building industry and has carried out appraisals of some asphalt membranes and shingles (refer paragraph 4.5.4).

health. The component of these shingles that is of particular concern to the authority is the asphalt binder, which is common to all the designs.

1.6 I therefore take the view that the matter for determination[5] is whether asphalt shingles, when used as part of a potable water supply system, comply with Clause G12 of the Building Code (First Schedule, Building Regulations 1992) in respect of chemicals or particulates leaching from the asphalt.

1.7 Matters outside this determination

1.7.1 This determination considers the code compliance of asphalt shingles, in general, when used in this context, in particular in regards to the asphalt as a component material. It does not consider the compliance of a particular brand or design of asphalt shingle, nor does it look at a particular building project where asphalt shingles have been used. Instead this determination considers whether there is anything inherent in the asphalt as a material in roofing shingles and as typically manufactured that would render any water supply system that incorporated asphalt roofing shingles non-compliant.

1.7.2 This determination does not consider additional components used on asphalt shingles such as fungicides or surface treatments. It should also be noted that roofing materials form only one part of the water supply system where rainwater is harvested and used as potable supply, and environmental effects or contamination does not form part of the matter being determined.

1.8 In this determination, I will refer to the following legislation, the relevant parts of which are set out in Appendix A.

- The *Building Act 2004* with its sections referred to as sections of the Act.
- Building Code Clause G12 – Water Supplies.
- Acceptable Solution G12/AS1 and Verification Method G12/VM1 for New Zealand Building Code Clause G12 Water Supplies.
- *Health (Drinking Water) Amendment Act 2007*.

1.9 In making my decision, I have considered the submissions of the parties, the report of the independent expert commissioned by the Ministry to advise on the dispute ("the expert"), and the other evidence in this matter. I have not considered any other aspects of the Act or of the Building Code.

2. The asphalt roofing shingles

2.1 The authority has asked me to consider compliance with the Building Code of asphalt roofing shingles when used as part of a potable water supply system.

2.2 In general, asphalt shingles are not manufactured in New Zealand, but are imported for distribution by various suppliers. This is true of the four suppliers that have been included as persons with an interest in this determination, which all import the asphalt shingles they supply from the United States of America.

2.3 I acknowledge that when considering a class of products, it is difficult to be specific about the components used in their manufacture. However, in general asphalt shingles incorporate a fibreglass mat, sandwiched between two layers of water-resistant asphalt, with the fibreglass serving as reinforcing. The top layer of asphalt

[5] Under section 177(1)(a) of the Act

is then embedded with ceramic-coated mineral chips, forming the rough upper-layer of the shingle. Two or more of these composites are then laminated together using asphaltic cement to form individual shingles. Some shingles incorporate a compound in the asphalt to make them algae-resistant.

2.4 When installed on a roof, shingles are generally laid over a roofing underlay over a plywood substrate. The shingles are fixed to the substrate using roofing nails and/or bitumen-based adhesives, with some shingles manufactured with self-adhesive strips. Flashings and other accessories are used to ensure the finished roof is waterproof along its ridges, gables, valleys, and eaves.

2.5 Asphalt shingles have been available in New Zealand since at least the 1970s. They are already widely installed, particularly in rural contexts, on many houses where water is collected from the roofs for potable use. It is reasonable to assume that their use in this context is likely to increase, as more designers, builders and homeowners seek to incorporate rainwater harvesting as an element of sustainable house design.

3. The background

3.1 In October 2014, the authority became concerned about the possibility that chemicals and particulates may leach from asphalt shingles used in situations where rainwater is being harvested roofs for potable use and contaminate the water supply. The authority was particularly concerned about the possibility that the asphalt used in the construction of the shingles could leach polycyclic aromatic hydrocarbons (PAHs).

3.2 In an effort to clarify the situation, a council officer researched the literature where this issue had been studied or discussed. The officer also contacted various industry professionals in New Zealand and Australia to seek their views on whether asphalt shingles should be used in rainwater harvesting situations, and to understand the extent of the tests available for components of potable water supply systems. In addition, the officer sought the advice of the New Zealand Ministry of Health, and contacted the various suppliers, asking the suppliers to provide evidence of any testing carried out for their products for 'compliance with NZBC/G12 and AS/NZS 4020:2005'[6] ("AS/NZS 4020").

3.3 As a result of this research, the authority appears to have decided that it would no longer issue building consents for building work that incorporated roofs clad with asphalt shingles in situations where potable water was to be harvested from the roof. This decision was communicated internally to council staff in an email dated 14 November 2014, and externally in relation to individual building consents.

3.4 The authority also appears to have decided that it would no longer accept testing of rainwater runoff, in line with the Drinking Water Standards of New Zealand 2005 (Revised 2008) ("DWSNZ"), as a means of establishing compliance with Clauses G12.3.1 and G12.3.2. This was communicated externally to at least one supplier.

3.5 On 9 December 2014, the authority applied for a determination about 'whether asphalt shingles used for the harvesting of rain [water] for potable use comply with NZBC/G12'.

3.6 The Ministry identified four suppliers of asphalt shingles in New Zealand as being persons with an interest in the matter to be considered (see paragraph 1.3). The Ministry provided these suppliers with a copy of the authority's application for

[6] AS/NZS 4020:2005: Testing of products for use in contact with drinking water

determination on 23 December 2014, and invited them to make a submission on 13 January 2015.

3.7 On 5 March 2015, the authority sought a direction under section 183 from the Ministry in relation to the issue under consideration in this determination, but this was subsequently withdrawn by the authority on 13 March 2015.

4. The submissions

4.1 The authority's submission

4.1.1 With its application, the authority made a submission outlining its concerns. These concerns stemmed from the mixed advice it had received from industry professionals and others about whether asphalt shingles should be used in situations where rainwater is being collected for human consumption.

4.1.2 The authority also stated that:

> None of the suppliers of Asphalt roof shingles have tested this product to the test AS/NZS 4020 or BS 6920[7] as required by G12/AS1, nor have they provided any robust or sound evidence of compliance as an alternative solution [with Clause G12].

4.1.3 With its submission, the authority included copies of:

- correspondence with industry professionals on the issue,
- correspondence with the Ministry of Health,
- excerpts from and references to various reviews and studies[8] about the suitability of using various roof materials in situations where rainwater would be harvested for potable use.

4.2 The other submissions

4.2.1 Three of the suppliers made a submission in response to the authority's application. These submissions are summarised in paragraphs 4.3 to 4.5.

4.2.2 The fourth supplier (supplier D) declined to make a submission on the authority's application, but stated that it supported the information submitted by the other suppliers regarding 'the safe use' of asphalt shingles for harvesting rainwater. Supplier D made a subsequent submission after having viewed the expert's report (see paragraph 6.2.7).

4.2.3 The Ministry of Health provided advice after receiving the expert's report (see paragraph 6.1).

4.3 Supplier A's submission

4.3.1 Supplier A made a submission dated 26 February 2015. In its submission, it stated that its asphalt shingles had been supplied and installed in New Zealand for 28 years, and that during that time it had not been notified of any 'issues or complaints' with respect to potable water collected from roofs clad with its shingles. Supplier A also

[7] British Standard BS 6290 Suitability of non-metallic products for use in contact with water intended for human consumption with regard to their effect on the quality of water.

[8] "Harvesting Rainwater for Human Consumption", *Level*. Web. 11 June 2015. http://www.level.org.nz/water/water-supply/mains-or-rainwater/harvesting-rainwater. "Rainwater Collection for Domestic Use." *BRANZ* Bulletin 1 October 2006. "Roof materials for rain water collection", *Massey University Roof water research centre* 2 June 2009. "Asphalt roofing – effect on drinking water quality" ex Wikipedia. "Effect of roof material on water quality for rainwater harvesting systems" *Texas Water Development Board* January 2010. "Effect of roof material on water quality for rainwater harvesting systems – additional physical, chemical and microbiological data" *Texas Water Development Board* January 2011.

stated that it accepted that AS/NZS 4020 'is a suitable test for determining the suitability of a roofing material to be used as part of a potable water system', and advised that it was currently undertaking testing to AS/NZS 4020 in Australia, with the final results due in March 2015.

4.3.2 On 3 March 2015, supplier A provided a "certificate of compliance" from the Australian testing laboratory confirming that the asphalt shingles provided 'fully complied with the test requirements of AS/NZS 4020:2005', together with a copy of the full test report. Supplier A stated that '[t]his provides evidence that [supplier A's] shingle meets the requirements of G12.3.2 as a potable water supply system.'

4.3.3 Supplier A also provided copies of correspondence with the authority regarding compliance of its product.

4.4 Supplier B's submission

4.4.1 Supplier B made a submission dated 26 February 2015. In its submission, it stated that its fibreglass asphalt shingles had been supplied and installed in New Zealand for the past 20 years, and that '[a]ll water samples that have been tested have meet (sic) New Zealand health requirements'.

4.4.2 Supplier B also outlined how, because asphalt shingles have a rough surface, contaminants can build up on them during periods where there is not much rain. Supplier B outlined the 'water management plan' that it recommended should be used with its shingles in situations where they are being used to harvest potable water. This plan incorporated a first flush system (to operate year round), a diversion system (for times when there is limited rain fall), and a filtration system installed between the water tanks and the roof. Supplier B concluded that;

> If you take the history, the [data], and the water collection management plan, there is no additional risk posed from collecting potable water from [our] fibreglass asphalt shingle roof than other roofing materials.

4.4.3 With its submission, Supplier B provided copies of:

- the manufacturer's material safety data sheet[9] for its shingles
- a United-States report[10] on toxic chemicals in roof runoff, which incorporated shingles with and without algae resistant copper-containing granules.

4.5 Supplier C's submission

4.5.1 Supplier C made a submission dated 27 February 2015. In its submission, it stated:

> Currently, we suspect many hundreds of asphalt shingle roofs installed throughout the country are being used to collect potable water, as this type of roof has become a popular choice for rural properties. There is no history of runoff from modified bitumen shingle roofing being a cause for health concerns.

4.5.2 Supplier C further stated that 'exhaustive testing' of water runoff from its shingle products demonstrates that this runoff is within the guidelines in the DWSNZ, and that the shingles complied with Clause G12. Repeated testing to DWSNZ in 2000 and 2008 has confirmed this compliance. Up until November 2014, the authority had accepted this testing as a means of demonstrating compliance with Clause G12. However, since November 2014, the authority had been requiring use of AS/NZS

[9] PABCO Roofing Products: Material safety data sheet for Fibreglass based asphalt shingles, Rev. 2
[10] Roofing materials assessment: Investigation of toxic chemicals in roof runoff from constructed panels in 2013 and 2014 *Department of Ecology State of Washington* September 2014.

4020. 'We believe [the authority] is asking us to comply with AS/NZS 4020 rather than complying with G12.'

4.5.3 Supplier C requested that it be able to 'continue to use our current DWSNZ 2005 testing as an alternative means of demonstrating compliance with G12', but also indicated that it was willing to undertake compliance testing under AS/NZS 4020, as it recognised that that was 'an appropriate pathway for shingles roofing products to meet building requirements'.

4.5.4 With its submission, Supplier C supplied:

- copies of BRANZ appraisals[11] relating to other modified bitumen roofing products,
- a copy of the BRANZ appraisal[12] relating to its shingles, which considered their compliance with certain clauses of the Building Code, but not Clause G12,
- various reports and other literature relating to the effect of roofing materials on the quality of potable water harvested from them[13],
- copies of correspondence between itself and various industry professionals about testing,
- correspondence between itself and the authority about the issue, including:
    - a copy of an internal email by the authority dated 14 November 2014, setting out its concerns about the compliance of asphalt shingles advising that building consents that 'detail asphalt roofing shingles … [where] the roof water is to be used for potable water…will not be approved'
    - a copy of an email from the authority dated 2 December 2014 that it stated that tests in accordance with DWSNZ 'are not a suitable substitute' for the test in AS/NZS 2040.

5. The expert's report

5.1 As mentioned in paragraph 1.9, I engaged an independent expert to assist me. The expert is a member of a Crown Research Institute, specialising in environmental science and research. The expert was engaged to review the documentation and related research, and provide a report about the matter being considered. The expert provided a report in early May 2015, and the report was forwarded to the parties on 5 May 2015.

5.2 The expert considered the available evidence (from published literature and research) that rainwater collected from a roof catchment clad in asphalt shingles is likely, or not likely, to meet the definition of potable water, as defined in the *Health (Drinking Water) Amendment Act 2007* and as specified in the DWSNZ.

[11] BRANZ Appraisals No. 647 (2009), No. 689 (2010), and No. 547 (2014)
[12] BRANZ Appraisal No. 529 (2012)
[13] "The contribution of particles washed from rooftops to contaminant loading to urban streams" 2nd International Symposium on Contaminated Sediments, *PC Van Metre, BJ Mahler.* " Waterquality of rooftop runoff: implications for residential water harvesting systems" Urban waterways series *North Carolina Cooperative Extension.* "Effect of roof material on water quality for rainwater harvesting systems" *Texas Water Development Board* January 2010. "Guidelines for Drinking-water quality management for New Zealand 2013" Chapter 19: Small, individual and roof water supplies, January 2014. "Assessment of rainwater quality from rainwater harvesting systems in Ontario, Canada" Journal of water supply: research and technology 2009.

5.3 The expert reviewed studies that had specifically investigated leaching from asphalt shingles, as well as studies that had examined the potential for contaminants to leach from asphalt used in other contexts (eg roads).

5.4 The expert looked at a wide range of organic and inorganic components that can potentially leach from asphalt into water. He collated the concentrations of these contaminants recorded in the literature and compared them to the maximum acceptable values (MAVs) set for them in the DWSNZ.

5.5 Table 1 lists the main contaminants identified in the report and the associated MAVs specified for them in the DWSNZ, alongside the range resulting from several laboratory tests provided by the suppliers.

TABLE 1: MAVs for chemical contaminants potentially leaching from asphalt roofing shingles

Contaminant	Concentration units µg/L	
	MAV	Supplier's laboratory testing results (range)
Inorganic		
Arsenic (As)	10	<0.3 - <1
Cadmium (Cd)	4	<0.1 - <1
Chromium (Cr)	50[a]	<0.1 – 2
Copper (Cu)	2000	<0.1 - <50-60
Lead (Pb)	10	<0.1 - <50
Mercury (Hg)	7	<0.03 - <0.1
Nickel (Ni)	80	<0.1 - <1
Vanadium (V)	No MAV assigned	
Zinc (Zn)[b]	No MAV assigned	<50
Organic		
Benzo(α)pyrene[c]	0.7	(no testing results supplied)
Di(2-ethylhexyl)phthalate (DEHP)[d]	9	(no testing results supplied)
Polybrominated diphenyl ethers (PBDE)	No MAV assigned	(no testing results supplied)
Pesticides[e]	0.04 (aldrin + dieldrin) – 900 (primisulfuron methyl)	(no testing results supplied)

[a] Provisional MAV.
[b] While no MAV has been assigned for zinc in New Zealand, a guideline value of 1.5 mg/L (1500 µg/L) has been specified for aesthetic impacts on drinking-water (taste)
[c] Benzo(α)pyrene is the only polycyclic aromatic hydrocarbon (PAH) for which a MAV has been assigned in New Zealand
[d] DEHP is the only phthalate for which a MAV has been assigned in New Zealand
[e] MAVs have been assigned for a wide range of pesticides. Only the range of MAVs for pesticides is reproduced here

5.6 It should be noted that:

- the expert considered evidence relating to many more contaminants that are considered potentially harmful to human health than those listed in Table 1 above,
- the range of components considered was necessarily limited by those that have been investigated in leaching studies performed on asphalt, particularly asphalt shingles,

- not all the potential contaminants have MAVs assigned for them in the DWSNZ,
- the expert did not consider contaminants that may occur in collected rainwater that do not originate from the constituent components of asphaltic roofing shingles (for example algae and bird droppings).

5.7 I also asked the expert to assess the likelihood of rainwater leaching substances of concern from materials that are commonly used in conjunction with asphalt shingles (for example, bituminous adhesives and light organic solvent preserved plywood). However, the expert found no relevant information on these materials.

5.8 As a result of the review, the expert was able to conclude that;

> In studies directly measuring or simulating rainwater runoff from asphalt shingle roofs, no contaminants have been reported in runoff water at concentrations above DWSNZ maximum acceptable values (MAVs).

Although one study found evidence that levels of aluminium and iron in rainwater run-off exceeded the guideline values in DWSNZ, this was not reflected in other studies. Although such elevated values may affect the palatability of water, they would not, in themselves, make it non-potable (refer also paragraph 9.1.5).

5.9 In regards to testing for leaching from road pavements, the expert noted that it

> …often involve[s] finely ground asphalt and long contact times between the leachant and the asphalt. In some cases studies also involve use of acidic leachant and agitation of the asphalt-leachant mixture. The fact that contaminant concentrations of concern were not extracted under such conditions suggests a good margin of safety for use of asphalt as a roofing catchment material for rainwater collection.

5.10 The expert also commented on measures to address the total contaminant load for runoff water:

> It should be noted that users of rainwater runoff for drinking-water purposes may employ measures such as first flush diversion, filtration or sterilisation. Even though the current report generally supports the use of asphalt roofing shingle as a suitable material for drinking-water collection, [studies suggest] that first flush diversion would be efficacious in reducing the total contaminant load in runoff water, while [another study] suggests that filtration or other measures to remove particulates from roof runoff should be encouraged.

5.11 The expert subsequently provided an addendum to his report on 2 June 2015: see Paragraph 7. The addendum was provided as a response to the parties' further submissions on the original report: see Paragraph 6.

6. Further submissions

6.1 The Ministry of Health

6.1.1 The Ministry of Health provided advice on 7 May 2015 in response to the expert's report. The main points raised were as follows.

- The expert's report is a literature review and did not involve tests for any of the asphalt shingle products available in New Zealand. The tests considered in the report would only be valid if the exact same product was imported into New Zealand.
- The manufacture of asphalt shingles may vary considerably, and 'each asphaltic product would need to [be] tested in accordance with the procedures of AS/NZS 4020 to determine if it was safe'.

- The drinking-water standards and guidelines do not include a maximum allowable value for the chemicals of concern in asphalt shingles. 'The [expert's] report does go into some values which can be used as levels that may not be of concern for human health.'
- Although the expert's report 'indicates a low risk in using asphalt shingles for collecting water for drinking', this is not supported by the latest advice from BRANZ, which states that bitumen-based roofing should not be used in situations where potable water is being collected.
- There are also concerns raised in international literature about roof shingles that are 'often heavily infused with anti-fungal chemicals to prevent moss growth', and the potential for these chemicals to contaminate potable water collection systems.

6.2 The Suppliers

6.2.1 The suppliers made further submissions in response to the Ministry of Health's advice and the expert's report. I have summarised the main points raised in those submissions below.

6.2.2 Supplier A (27 May 2015):

- AS/NZS 4020 is an appropriate test for asphalt shingles, and has been used to demonstrate the compliance of various bitumen-based membranes currently used in New Zealand.
- Asphalt shingles are installed on pitched roofs (greater than 10 degrees), and as a result 'the risk of leaching or contamination is significantly lower than that of water collected from a [flat membrane roof]'. Rainwater falling on a pitched roof will only be in contact with the shingles for a short period of time.
- 'There is no scientific evidence that confirms asphalt shingles or bitumen based membranes leach any material in sufficient quantities to be harmful to people.'
- Light organic solvent preserved (LOSP) plywood is not used within asphalt shingle roofing systems. The plywood used is either untreated or copper chromium arsenate (CCA) treated, and is separated from the shingles by an underlay. Similarly, any bitumen-based sealants used are applied under the shingle as an adhesive, and do not come into contact with rainwater.

6.2.3 Supplier C (26 May 2015):

- The expert's report is supported, and is 'most relevant', as most of the brands of shingles considered in the report are represented in New Zealand. In addition, data sheets show that 'shingle composition is very similar between different brands, with modified asphalt being 20-30% of the total composition in most brands of shingle'.
- Although BRANZ has commented 'generally' that it doesn't 'recommend bitumen based roofing products for use with potable water', it has recently conducted three appraisals for bitumen-based roofing, which have included their suitability for use with potable water systems and compliance with AS/NZS 4020.
- The expert's report confirms international studies that have found that the primary concern relating to PAHs in roof runoff relates to 'environmental or atmospheric contamination from roadways and airborne pollutants. The

studies indicate there was little evidence to show PAHs leaching from the roofing material above accepted guidelines'.

- 'It is impractical to conduct an infinite amount of testing therefore, currently DWSNZ and AS/NZS 4020 are the most appropriate means of testing available to us. These tests are extensive and robust, and used throughout New Zealand for all types of products including plastics, metals, composites and also bitumen.'

6.2.4 With its further submission, Supplier C provided copies of technical literature relating to the algae-resistant asphalt shingles it supplies which include copper granules in the composite.

6.2.5 Supplier C (18 June 2015)

- In the report provided by the authority (refer paragraph 6.3 below), the test samples appear to be liberally contaminated due to the environment in which they were harvested, with contamination by other building products and environmental factors making it difficult to draw any accurate or useful conclusion.
- Long dry spells followed by rain events typically result in pollen washing into water tanks and tinting the water yellow. Filtering does not always guarantee pollen will be removed, and many houses are not fitted with first flush systems.
- Environmental contamination is not unique to shingle roofing but is typical of all roof types where rain water is harvested.
- Supplier C has undertaken extensive laboratory testing.

6.2.6 Supplier C also provided a copy of a certificate of conformance dated 12 June 2015 for AS/NZS 4020 testing of its roofing shingles.

6.2.7 Supplier D (28 May 2015):

- Decisions about the suitability of asphalt shingles in rainwater harvesting situations should be based on 'the facts and actual test results'. No tests conducted on asphalt shingles to date 'have returned any negative results for toxins that would prove harmful to human health in unfiltered samples'.
- 'Efficient collection and filtration procedure[s]' should always be used where rainwater is being collected for potable use, especially in rural locations. Supplier D has 'minimum filtration requirements' that it recommends to its clients, incorporating a first flush system, two different types of cartridge filters, and a loose carbon media filter tank, with the optional addition of a UV or other type of sterilisation filter.
- AS/NZS 4020 is an acceptable test for components that are in contact with domestic water supply systems, including roofing materials.
- Algae-resistant shingles, including those supplied in New Zealand, have been tested overseas. This testing is 'very comprehensive and specific for toxins', with no evidence of contamination found.

6.3 The authority

6.3.1 Further information was received from the authority on 12 June 2015, being a report with the subject line 'Discoloured water Collected from a new Shingle Roof'. Some information in the report was redacted, and only the date of the report was evident (2 March 2015). The authority named the report's author and said he was a 'senior lecturer' at a New Zealand university. It appears the lecturer has specific expertise in many aspects of rainwater harvesting.

6.3.2 The report provided comment on a 'sample of the roofing [shingles] as well as some of [the] tank water, as collected and the water after treatment by [the] system' to determine the cause of a yellow colour in the tank water. The water treatment system is not described in the report. The report concluded that the of the water's yellow colour did not appear to be associated with the 'bituminous' component of the roof, but organic material was 'probably' associated with additives used in the manufacture of the asphalt shingles or surface active agents or coatings. The report concluded that the water sampled from the tank is 'probably not suitable for potable or drinking purposes'.

6.3.3 I consider the report's findings are limited in their ability to inform the discussion herein: the testing appears to show the water contamination arose from that tank itself and not the roofing material.

6.4 The clarification

6.4.1 Following the issue of the determination on 7 September 2015, the authority sought a clarification under section 189 of the Act on 24 September 2015. The request for clarification in general terms was in regards to the wording of the determination decision and sought a clear statement on what was excluded or included in the compliance decision and the effect of the decision in regards to testing requirements.

6.4.2 On 25 September 2015 I wrote to the parties with a proposal for amendments to wording in the determination; the proposed clarification was also copied to the suppliers and BRANZ.

6.4.3 The authority responded on 28 September 2015 accepting the proposed amendments.

6.4.4 An officer of the Ministry of Health responded on 29 September 2015, agreeing on the need for a clarification, and suggesting additional wording to refine the decision. The officer also noted that treatments mentioned in paragraph 9.3.4 are largely for reduction of microbiological and particulate contamination rather than chemical contamination.

6.4.5 On 29 September 2015 the authority sent a further response noting it agreed with the additional wording suggested by the Ministry of Health.

7. Addendum to the expert's report

7.1 On 2 June 2015, the expert provided an addendum to his report, in response to the Ministry of Health's advice (see paragraph 6.1).

7.2 In his addendum report the expert reconfirmed the view reached in his original report that there was no evidence that contaminants of concern could leach from asphalt materials when used in a potable water context.

7.3 In response to the Ministry of Health's concern that the original report had only reviewed the available literature and not involved any independent testing, the expert clarified that the review

> ... represents a body of evidence and included information from testing carried out on the products on the New Zealand market.
>
> The review did not confine itself to particular products or to roofing shingles, in particular. Instead, the review sought evidence that contaminants of concern in a potable water context could be leached from asphalt materials. The evidence suggests not.

7.4 The expert further referred to the various studies mentioned by the Ministry of Health in its advice, that had concluded that asphalt should not be 'used as a roofing material for collection of rainwater' due to the risk of 'leaching of toxic compounds', and noted that 'none of these sources provide or reference evidence to support this contention'. This included the advice from BRANZ, which 'may or may not' need to be updated, and either way 'should be based on a suitable body of evidence'.

7.5 In his addendum report, the expert addressed the specific issue of PAHs leaching from asphalt shingles:

> Scientific studies on water-leachable material from asphalt roofing shingles and other forms of asphalt have consistently focussed on potential leaching of polycyclic aromatic hydrocarbons (PAH) and contaminant elements, such as arsenic, cadmium, copper, lead, mercury, nickel and zinc. There are MAVs or guideline values (GL) for these contaminants in DWSNZ, as discussed in the [expert's original] report. While it is true that there are no MAVs for a wide range of PAH that may occur, there is a MAV for benzo(α)pyrene, which is generally considered to be the member of this class of compounds of greatest concern with respect to public health.

7.6 The expert also observed that where there is potential for 'potentially toxic non-asphalt components', such as fungicides, to be include in the composition of asphalt shingles, these issues should be 'addressed on a case-by-case basis', using the following approach:

> In assessing the potential for compounds, such as fungicides, to leach from roofing shingles it would seem to be more sensible to analyse run-off water for the chemical of concern, rather than the generalised testing requirements of AS/NZS 4020.

7.7 The Ministry of Health provided comment on the Addendum report, noting that the chemicals identified to be of health concern are the ones to test for: (benzo(α)pyrene, arsenic, cadmium, copper, lead, mercury, nickel, and zinc). The Ministry of Health also commented that 'any testing for chemicals of concern should follow the sample preparation procedures of AS/NZS 4020 (ie don't just go out and test a tank of rainwater from a roof with asphalt [shingles])', and that the standard also has tests for taste, odour and appearance which are important in regards to the fitness for purpose test under consumer legislation.

8. The draft determination and responses received

8.1.1 A draft determination was issued on 7 July 2015 to the parties and persons with an interest for comment.

8.1.2 The Ministry of Health provided comment on the draft by email on 9 July 2015, noting that

- It is unclear in Supplier C's submission what determinands[14] in the DWSNZ were tested for. It was understood that only some heavy metals had been tested for, and no PAH or more specifically benzo(α)pyrene had been looked for.
- Table 1 (refer paragraph 5.5) required amendment to make the results column for the last four entries clear. (I have subsequently amended this to record that no results for those contaminants were included in the testing results).
- As well as AS/NZS 4020 or the DWSNZ (presumably against the appropriate determinands), there are also equivalent overseas approvals that would be acceptable.
- Health officials agree with the expert (refer paragraph 7.5) that if testing to the DWSNZ were carried out it must include the determinands in the DWSNZ e.g. benzo(α)pyrene, and heavy metals.
- The determination discussion should be clear that the specific determinands need to be tested for (as above).
- The determination decision as drafted could be interpreted to mean that no new asphalt shingle products need to be tested at all unless they are known to contain fungicides or surface treatments; this is not supported by Health officials.

8.1.3 The Ministry of Health noted that it had received a discussion paper from the Australian Building Codes Board for comment, in which it was noted 'bitumen and tar should not be used for rainwater catchment areas'[15]. It was also noted that water used in food preparation is covered under the *Food Act*, which is administered by the Ministry of Primary Industries.

8.1.4 On 10 July 2015 Supplier D provided a response accepting the draft and providing a copy of a certificate of conformance, dated 11 June 2015, for AS/NZS 4020 testing of its roofing shingles. Supplier D said the term 'bitumen' used by the Ministry of Health (reference paragraph 8.1.3) had 'many variations' and its relevance to the determination was questioned.

8.1.5 The authority, and Suppliers A, B, and C accepted the draft without further comment in responses received between 17 July and 20 July 2015.

8.1.6 No comment was received from BRANZ in response to the draft determination.

[14] The DWSNZ defines determinands are defined as 'A constituent or property of the water that is determined, or estimated, in a sample…'. Determinands can include microbial, chemical, physical and radiological determinands. Some determinands have a health significance and some do not.

[15] The source reference is taken from EnHealth 'Guidance on use of rainwater tanks', Environmental Health Committee of the Australian Health Protection Committee, dated March 2011. Under the heading 'Paints and coatings', the guidance document says 'bitumen-based (tar) materials – are generally not recommended, as they may leach hazardous substances or cause taste problems.'

9. Discussion

9.1 General

9.1.1 The authority has sought a determination about whether rainwater collected from roofs clad in asphalt shingles can be safely used as potable water. The authority is concerned that the asphalt used in the shingles may leach chemicals and particulates that may be damaging to human health.

9.1.2 The relevant clauses of the Building Code are G12.3.1, and G12.3.2. These clauses set the performance requirements that potable water supply systems in buildings must comply with.

> **G12.3.1** Water intended for human consumption, food preparation, utensil washing or oral hygiene must be potable
>
> **G12.3.2** A potable water supply system shall be–
>
> (a) protected from contamination; and
>
> (b) installed in a manner which avoids the likelihood of contamination within the system and the water main; and
>
> (c) installed using components that will not contaminate the water.

9.1.3 Under section 19 of the Act, building consent authorities must accept compliance with an Acceptable Solution as establishing compliance with the Building Code. The Acceptable Solution for Clause G12, G12/AS1, specifies tests that can be used to demonstrate that the materials and components that go into water supply systems will not contaminate potable water.

> **2.1 Water quality**
>
> 2.1.1 Components of the water supply system shall not contaminate potable water.
>
> 2.1.2 Water supply materials and components shall comply with:
>
> a) BS 6920 if non-metallic, or
>
> b) AS/NZS 4020 if metallic or non-metallic.

However, an Acceptable Solution provides one way, but not the only way, of establishing compliance.

9.1.4 G12/AS1 defines potable water as: 'Water that is suitable for human consumption'.

9.1.5 The *Health (Drinking Water) Amendment Act 2007*[16] defines potable more specifically as:

> **potable**, in relation to drinking water, means water that does not contain or exhibit any determinands to any extent that exceeds the maximum acceptable values (other than aesthetic guideline values) specified in the drinking-water standards.

Determinands and their associated MAVs are specified in the DWSNZ. MAVs are those levels beyond which water becomes non-potable. DWSNZ also specifies lower guideline values for determinands. Guideline values are the levels that it is recommended that individual determinands do not exceed, if potable water is to maintain its aesthetic qualities (such as taste). Levels above the guideline values will not render water non-potable until the MAVs are reached.

[16] http://www.legislation.co.nz/act/public/2007/0092/latest/DLM969845.html Accessed 8 April 2015

9.2 Test methodologies

9.2.1 Any supplier of asphalt shingles can have their product tested in accordance with AS/NZS 4020: that Standard specifies a testing schedule for products that are used in contact with drinking-water. The testing schedule includes:

- taste of water extract,
- appearance of water extract,
- growth of aquatic micro-organisms,
- mutagenic activity of the water extract,
- cytotoxic activity of the water extract,
- extraction of metals,
- high temperature tests (only for products in contact with hot water).

9.2.2 However, as I have stated above, AS/NZS 4020 provides only one way of demonstrating compliance. Some of the suppliers in the current case have instead chosen to have their products tested in accordance with DWSNZ; that is, to establish whether rainwater collected from their products contains determinands at levels that exceed the MAVs. In the past, the authority and its predecessors have accepted this testing as an alternative solution for demonstrating compliance with Clause G12.

9.2.3 The tests in AS/NZS 4020 and the DWSNZ take different approaches. The former specifies an effect (an assessment of various aspects of the state of the water), rather than measuring the determinands that may create that effect (the approach taken in DWSNZ).

9.2.4 With respect to the potential toxicity or harmfulness of contaminants that may be leached into rainwater, DWSNZ provides a more comprehensive test. The MAVs it provides take into account the full range of toxicological information. AS/NZS 4020 on the other hand, only takes into account and tests for a more limited range of toxicological effects (namely mutagenicity and general cell toxicity) that contaminated rainwater may have.

9.2.5 This difference between the two tests was discussed by the expert in his addendum report, where he states that:

> in our opinion, the requirements of AS/NZS 4020 and the requirements of the [DWSNZ] are not necessarily equivalent and contaminants may be present in water at concentrations above New Zealand maximum acceptable values (MAVs), while still complying with AS/NZS 4020.

9.2.6 However, the test in AS/NZS 4020 is broader in other respects, in that it takes into account the aesthetic values of potable water, including its appearance and taste. Several of the determinands tested for in DWSNZ, if present in water at levels that exceeded their guideline values (rather than their MAV), would render water unpalatable, even though it would still be considered potable.

9.2.7 The reason for the effects-based approach adopted in AS/NZS 4020 was explained by an officer of the Ministry of Health, in an email to the authority dated 4 December 2014. I quote it here to provide clarity about the reasoning behind the test, and what is and is not included within the its scope:

> There are about 150 different determinands in the [DWSNZ] which would not be practical or reasonable for [AS/NZS] 4020 to check. Instead to determine if a product is safe and suitable for use in contact with drinking-water, [AS/NZS 4020] requires

> tests for taste, appearance, growth of aquatic micro-organisms, cytotoxicity, mutagenicity and extraction of metals (dependant on whether the type of product is used in-line, end of line or hot water system (as set out in a table in [AS/NZS 4020]).
>
> As any concern with PAHs leaching from asphalt [shingles] is carcinogenic risk (rather than acute), the tests for cytotoxicity and mutagenicity cover that risk. So if an asphalt [shingle] had been assessed for [AS/NZS] 4020 and had the appropriate tests (Appendix F for cytotoxic response and Appendix G for mutagenic activity) it will be OK to use in contact with drinking water…
>
> Re the DWSNZ and not having a MAV for PAHs, PAHs cover a large range of chemicals. However the main chemical of concern benzo(α)pyrene…does have a MAV which is 0.0007mg/L.

The email also touches on the authority's concerns (raised in its correspondence with the parties and industry experts) about the potential for asphalt shingles to leach PAHs into drinking water (see paragraph 3.1).

9.3 Assessment of code compliance

9.3.1 As discussed in paragraphs 5.2 to 5.4, the expert reviewed available research literature to determine if asphalt would leach contaminants to a level that would make it unsafe for human consumption (non-potable). To this end the expert collated information about all the contaminants tested in the research, and compared the levels detected with the MAV specified in DWSNZ. In an effort to broaden the information captured, the expert also considered research about the potential for contaminants to leach from asphalt that is exposed to rainwater in other situations, for example on roads.

9.3.2 I accept the expert's finding that, at present, there is no evidence to suggest that rainwater harvested from roofs clad in asphalt shingles is unsuitable for human consumption. Although it is tangential to the current issue, like the expert, I consider it notable that testing for leaching from road pavements is rigorous and the results did not raise concerns regarding the use of asphalt shingles for rainwater collection.

9.3.3 I support the view put forward by the expert that where there is potential for potentially toxic non-asphalt components, such as fungicides, to be included in the composition of asphalt shingles, this issue should be addressed.

9.3.4 Asphalt shingles only form only one part of the water supply system where rainwater is harvested and used as a potable supply. Given that contamination can occur through material deposited on the roof, and other associated environmental effects, appropriate filtration and treatment of the harvested water should be used to maintain water quality.

9.4 Conclusion

9.4.1 I conclude that, at present, there is no evidence to suggest that asphalt shingles, when used as part of a rainwater harvesting system, will leach contaminants or particulates to an extent that would make the collected water unsuitable for human consumption (non-potable). Accordingly I consider the asphalt shingles in themselves do not compromise the compliance with Clause G12 of the Building Code.

9.4.2 Clearly, the processes and components used in manufacturing asphalt shingles will vary from product to product. It is up to individual suppliers to demonstrate their product's compliance with Clause G12; in addition to verifying the composition of the base material as asphalt, suppliers must address any additional components used such as fungicides or surface treatments.

9.4.3 The test set out in AS/NZS 4020 is one way, but not the only way of demonstrating such compliance. In the past, suppliers have also used the tests in DWSNZ, and I conclude that this approach is also an adequate means of establishing compliance as an alternative solution subject to the testing including PAHs and contaminant elements. Nothing in this determination should be taken to infer that either of these tests is compulsory: the Building Code is performance-based, and suppliers may use other means, including other tests, to establish compliance.

9.4.4 The decision made here is not to be taken as a blanket approval of all asphalt shingles, and the approval of individual products should be conducted on a case-by-case basis.

9.4.5 I accept the guidance, provided initially by the Ministry of Health and subsequently reinforced by the expert, that testing carried out as described in AS/NZS 4020 or DWSNZ is adequate to determine the safety of drinking water collected from asphalt shingles. Successful testing using either standard will be sufficient to allay the authority's concerns.

9.5 Other matters

9.5.1 I acknowledge that at least two of the suppliers, upon learning of the authority's concerns, promptly had their products tested to AS/NZS 4020 in order to demonstrate compliance with Clause G12. I applaud these suppliers for their actions.

10. The decision

10.1 In accordance with section 188 of the Building Act 2004, I hereby determine that asphalt roofing shingles used as part of a potable water supply system, if verified as set in paragraphs 9.4.2 to 9.4.5 of this determination, comply with Clause G12 of the New Zealand Building Code in respect of chemicals or particulates leaching from the asphalt.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 5 October 2015.

John Gardiner
Manager Determinations and Assurance

Appendix A: The legislation and the relevant Acceptable Solution

A1. Building Code Clause G12 Water supplies says:

G12.3.1 Water intended for human consumption, food preparation, utensil washing or oral hygiene must be potable

G12.3.2 A potable water supply system shall be–

(a) protected from contamination; and

(b) installed in a manner which avoids the likelihood of contamination within the system and the water main; and

(c) installed using components that will not contaminate the water.

A2. The Acceptable Solution for Building Code Clause G12 Water Supplies includes:

Definitions (p. 11)

Potable (and potable water) Water that is suitable for human consumption.

Acceptable Solution G12/AS1 (p. 17)

1.0 Scope

1.0.1 This acceptable solution applies to below ground and above ground piped water supply systems.

2.0 Materials

2.1 Water quality

2.1.1 Components of the *water supply system* shall not contaminate *potable water*.

2.1.2 Water supply materials and components shall comply with:

a) BS 6920 if non-metallic, or

b) AS/NZS 4020 if metallic or non-metallic.

A3. Health (Drinking Water) Amendment Act 2007

Section 69G Interpretation

potable, in relation to drinking water, means water that does not contain or exhibit any determinands to any extent that exceeds the maximum acceptable values (other than aesthetic guideline values) specified in the drinking-water standards