Ministry for Primary Industries
Manatū Ahu Matua

Report on the Targeted Surveillance of Milk from Animals Potentially Exposed to Petrochemical Mining Wastes

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Updates

Through review and the receipt of updated information some of the units of measurement presented in the original issue of this report have been updated, along with some minor typographical errors.

These updates have no impact on the analysis and statements set out in the original report and the conclusions remain unaffected.

Disclaimer

Every effort has been made to ensure the information in this report is accurate.
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This publication is also available on the Ministry for Primary Industries website at
http://foodsafety.govt.nz/industry/sectors/dairy/monitoring-testing/nccp/documents.htm

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1 Executive Summary

In April 2014 MPI conducted targeted surveillance of milk from 20 dairy farms to assess the safety of milk from animals potentially exposed to farm land used for the bioremediation of solid wastes from petrochemical mining.

Milk samples were collected from 17 farms that have received petrochemical waste solids for bioremediation, either as a surface “landfarm” application or a “mix-bury-cover” whereby the solids are mixed with soil and buried below the pasture root zone. Three control sites from outside the Taranaki region have also been included as controls for comparison.

Testing for a wide range of compounds and minerals covering both inorganic and organic chemicals, most with known associations to fossil fuel production and mining operations, were included in the surveillance study. Four compounds or minerals were found at very low levels while the remainder of the compounds and minerals tested for were not detected.

The surveillance study identified that only very low levels of some of the chemical compounds or minerals that were tested for were found and these did not represent a risk to consumers. Further, there was no evidence to suggest that these very limited detections in milk were due to exposure to wastes from petrochemical mining. This conclusion is consistent with the initial assessment and the findings that Fonterra have advised. It also reflects the outcome of bioremediation when undertaken correctly and with animals withheld until the soil has returned to a normal state for grazing.

As milk is a highly sensitive food matrix for identifying the possible presence of chemical hazards, there is no immediate need to conduct further studies for meat.

MPI operates a number of programmes that monitor for chemical residues and environmental contaminants in various foods, with extensive programmes focused on milk, dairy products, meat and other animal products. Farms receiving petrochemical wastes will continue to be included in the MPI national residue monitoring programmes. MPI will also continue to monitor farming activities and take these into consideration when reviewing the content of the various monitoring programmes.

2 Purpose of this report

The purpose of this report is to present the findings of MPIs targeted surveillance of raw milk from animals potentially exposed to farm land used for the bioremediation of solid wastes from petrochemical mining. This testing was undertaken to gain further evidence to support MPIs initial assessment and determine whether further investigations are warranted.

3 Background

3.1 DAIRY NATIONAL CHEMICAL CONTAMINANTS PROGRAMME

Dairy monitoring and surveillance programmes for selected substances of interest have been in operation in New Zealand for many years, and a national programme monitoring raw milk was introduced in the 1996/97 dairy season. Since that time the programme has become an official programme under the Dairy Industry (National Residue Monitoring Programme) Regulations 2002, and is administered by the Ministry for Primary Industries (MPI).

New Zealand's dairy monitoring and surveillance programme is better known as the National Chemical Contaminants Programme (NCCP) and is designed to confirm the effectiveness of the regulatory controls in place for ensuring chemical residues in milk and manufactured dairy products do not pose a threat to human health; that good agricultural practices are being followed; and that all relevant importing country requirements will be met. In addition surveys are undertaken as necessary to identify new or emerging risk factors or enhance the understanding of potential issues and natural background levels for minor components naturally in milk.

The monitoring programme is regarded as confirmation that controls are working effectively and as such it serves as a verification measure and not a primary control measure. The programme is designed to identify where controls may not be working and enable an appropriate investigation to be undertaken to determine the root cause and establish options to correct the situation. Under this programme over 320 raw milk samples and a range of manufactured dairy products are sampled and over 160,000 individual test results obtained each year.

The particular chemicals monitored, the number of samples to be analysed, and the sampling pattern are determined following consideration of factors relevant to New Zealand production practices. Due consideration is given to historical monitoring results which have thus far indicated that New Zealand's controls are effective in ensuring chemical residues in dairy products conform to applicable limits and that consumers can be assured that manufactured dairy products are safe and wholesome.

Factors taken into consideration in the design of the programme are covered under section 4.5. Action limits are established for all residues of primary interest in the programme. Where Maximum Residue Limits (MRLs) have been set, the action limit is typically set at the lowest value applied under New Zealand, Codex, and Importing Country MRLs. Where a compound is not permitted for use on milking animals the action limit is set at the limit of detection (LoD).

For compounds or chemical elements naturally occurring in raw milk, the action limits are set to identify unexpected levels that warrant further investigation. Regulatory response to identified 'control failures' is aimed at motivating not just the individual farmer or processor directly concerned, but the whole sector responsible for the particular control so that the required adjustments can be applied on a national basis if necessary.

The overarching purpose of the Dairy National Chemical Contaminants Programme is to:

a) provide an assurance that raw milk at the farm vat conforms to New Zealand and international requirements;
b) confirm the accuracy of attestations provided to other countries; and
c) investigate unfavourable findings to ensure that controls remain effective and that emerging hazards are identified and an appropriate regulatory measures applied.

3.2 PETROLEUM MINING WASTES APPLIED TO FARM LAND

Land farming is the process whereby drilling wastes (typically rock cuttings with residual muds and some hydrocarbons and water based and synthetic based muds) are disposed of via shallow application to land. The practice is a valid and environmentally acceptable means of waste treatment with appropriate controls and is successfully used overseas. Wastes are incorporated into soil allowing natural bioremediation and various soil processes to biodegrade, transform and assimilate wastes.

To date in Taranaki, land farming has consisted of single applications of drilling wastes to designated treatment areas. Once spread, the waste is incorporated into the soil and covered with previously removed topsoil and regrassed. To date there are 12 land farm sites (some of which are now closed and reinstated in pasture) and only one has been consented to dispose of return fluids from hydraulic fracturing in the region and it has been completed and closed.

Mix-bury-cover of drilling wastes is a type of land based disposal that is not in current general use. It involves the disposal of solid drilling waste (cuttings and residual fluids) onto or into land at depth. Solid drilling waste is mixed with clean soil and buried below the major rooting zone and above the water table, and regrassed. The activity involves a single application of a designated area of land. The area and thickness of application are determined by the loading rates specified in the resource consent. Once spread, the waste is incorporated into the soil and covered with previously removed topsoil. While around 80 consents for mix-bury-cover have been granted, only around 30 have ever been exercised, with just 2 exercised in recent years. It should also be noted that when wastes are applied to land for bioremediation purposes, as is the case for landfarms and mix-bury-cover, the area concerned represents only a small portion of the total farm.

Land farming is regulated by resource consent under the Resource Management Act with up to 25 conditions that are regularly monitored. The approach used reflects best overseas practice. Monitoring results are presented to the community in annual compliance monitoring reports. Throughout this report, unless otherwise stated all references to landfarms refer to both landfarm and mix-bury-cover as described above.

3.3 INITIAL ASSESSMENT

The use of landfarms and mix-bury-cover for the disposal of petrochemical drilling wastes in Taranaki is not new. When MPI undertook an initial assessment of landfarming in light of potential chemical hazards posing a risk of chemical residues or contaminants carrying over to food produced by animals it was concluded that the food safety risk was deemed low. This view took into account the manner in which councils regulated the activity under the consents, the type of compounds that would commonly be in drilling muds and cuttings, and the effect of the soil remediation process.

To further strengthen risk management provisions covering dairy production MPI placed an obligation on dairy farmers to notify their dairy company if they were intending to accept wastes such as those directed to landfarms. This step enables dairy companies to be aware of the activity and to ensure that chemical residue risks are managed appropriately.

MPI undertook a targeted round of testing to add a series of results independent of industry findings and to determine whether there is a case for additional controls being required for farms that accept petrochemical wastes for bioremediation. This report presents the findings and updated conclusions based upon the surveillance undertaken.

4 Sampling and Testing Design

In designing the testing programme MPI have taken into consideration:

- how many dairy farms are understood to have landfarms or mix-bury-cover sites
- seasonal influences that should be considered for sampling purposes
- chemical compounds that are typically not present in milk that might come from petrochemical wastes or the management and handling of the wastes
- chemical compounds that are commonly found in milk at low levels, but would likely show a pronounced spike if milking animals were to be exposed to the compounds
- chemical compounds and tests that are routinely monitored and that might be useful indicators of chemical contaminants such as antimicrobial residues.
- compositional tests to confirm the milk constituent levels.

4.1 FARMS

MPI identified 17 dairy farms that have, or may have, received petrochemical wastes from drilling or production activities. These farms represent both landfarms and mix-bury-cover.

For control purposes three farms outside Taranaki have been included, one in the Bay of Plenty region, one in Marlborough, and one in Southland. The control farms were selected randomly with no bias regarding the breed of cows, feed used, fertiliser history or husbandry practices.

All farm selections were made by MPI.

4.2 SEASONAL TREND IN COMPOSITION

Dairy farming in New Zealand is pasture based and the milk production pattern is seasonal, following a pasture production curve. For the screening of milk to identify any indications of exposure to wastes MPI elected to sample near the end of lactation when fat levels are typically at their highest. Late in lactation milking animals are also likely to be losing accumulated fat, meaning that fat soluble compounds accumulated in body fat over an extended period are more likely to be transferred to the milk and more readily detected.

Accordingly sampling occurred at the end of April 2014, near the end of the milking season, when residue levels could be expected to be at their highest. The composition of each milk sample was measured and the milkfat and protein levels for most farms are elevated, indicating the herds were near the end of lactation (refer Table 6).

4.3 SAMPLING

MPI worked closely with Global Proficiency Ltd, a subsidiary of AsureQuality, to arrange the collection of samples. The standard NCCP sampling procedures applied with the exception that special stainless steel sample containers were required for the saturated hydrocarbon analysis. Sampling was undertaken by independent AsureQuality dairy samplers, with raw milk collected from the farm bulk milk tank. While the ideal would have been to collect samples directly from the cows to avoid any trace of chemical compound migration into the milk from milking equipment components, this is largely impractical.

4.4 DETERMINATION OF COMPOUNDS TO SCREEN

Other factors taken into account for any selected compound, in addition to the considerations set out under 4 are:

- good agricultural and veterinary practices, including animal husbandry,
- extent and pattern of use of the chemical (including risk prone times),
- programmes or controls in place to mitigate the risk of milk becoming affected by chemical hazards,
- toxicological significance of the substance,
- potential for misuse or abuse,
- exposure routes, including feed and environment,
- persistence in the environment (including risk prone areas),
- previous monitoring frequencies and findings (across MPI, industry programmes and international monitoring),
- availability of a practical, validated analytical method,
- international concern about residues of the compound, and
- regulatory requirements of international markets.

4.5 SUBSTANCES & ANALYTES

4.5.1 Compounds

The following compounds are of primary interest as the presence of several of these compounds in one sample may provide evidence of animal exposure to petrochemical wastes:

- Polycyclic aromatic hydrocarbons (PAHs)
- BTEXS (benzene, toluene, ethyl benzene, xylene meta-,para, xylene ortho- and styrene)
- Polybrominated diphenyl ethers (PBDEs)
- Mineral oil aromatic hydrocarbons, and
- Short to medium chain saturated hydrocarbons

Longer chain saturated hydrocarbons have been included along with polybrominated diphenyl ethers (PBDEs). Though neither is a conclusive marker, these have been included to provide MPI with a more complete picture.

4.5.2 Chemical Elements

Given the low level of industrialisation in New Zealand there is little anthropogenic heavy metal contamination within the environment. As set out under section 3.2 landfarming is controlled through a consent process which may include monitoring of land or the activity. These factors mean that the heavy metals of concern should not be present in milk at levels that would cause concern. Accordingly this milk programme includes testing for arsenic, lead and mercury.

In addition, vanadium and barium are known to be associated with oils and petrochemical exploration respectively and have been included. Antimony and flouride have also been included as they could be present in drilling cuttings.

4.5.3 Composition

To characterise the composition of the milk each sample was tested for the major milk components. The national average milkfat and protein levels in cows milk are 4.97% and 3.81% respectively. Toward the end of lactation the levels will increase markedly. For fat soluble compounds it is often useful to express results on a fat basis or to correct to a standard 4% milkfat milk basis.

4.6 LABORATORIES

To cover the range of compounds of interest MPI contracted the four laboratories in Table 1 to undertake the testing.

Table 1: Laboratories contracted to undertake testing

Laboratory	**Testing Performed**	**Test method**
Eurofins	Mineral Oil Saturated Hydrocarbons Mineral Oil Aromatic Hydrocarbons BTEXS (benzene, toluene, ethyl benzene, xylene meta-,para-, ortho-, and styrene)	Online coupled Liquid Chromatography-Gas Chromatography-Flame Ionisation Detection Online coupled Liquid Chromatography-Gas Chromatography-Flame Ionisation Detection Headspace Gas Chromatography-Mass Spectrometry
AsureQuality Wellington	Polycyclic Aromatic Hydrocarbons (PAHs) Polybrominated diphenyl ethers (PBDEs)	Gas Chromatography-High Resolution Mass Spectrometry Gas Chromatography-High Resolution Mass Spectrometry
AsureQuality Lynfield	Metals Flouride	Inductively Coupled Plasma-Mass Spectrometry Ion Selective Electrode
MilkTestNZ	Milk Composition Inhibitory Substances	Fourier Transform Infrared Spectrometry Antimicrobial plate bio-assay

5 Findings

Few compounds were detected given the extensive range of tests undertaken and the nature of a pasture based grazing system. The following explains what we did find, what we didn't find, and what this means in terms of exposure to petrochemical wastes.

5.1 WHAT WE FOUND

5.1.1 Barium

Barium is an alkaline earth metal. It occurs naturally in the earth's crust and in soils. Reported soil levels for New Zealand (Auckland) range between 8 -350mg/kg (ARC, 2001), with volcanic soils having higher reported levels than non-volcanic soils.

Barium was reported in all milk samples including all three control samples. Levels of barium were similar across all samples.

Barium sulphate is known to be utilised in oil drilling operations as a weighting agent for the drilling fluid so the purpose of testing for this compound was to see if any discernable spike could be identified that might indicate exposure to significantly higher level than would typically occur from New Zealand soils and pasture.

Barium sulphate is highly insoluble. It is used in human medicine for 'barium meals' as it does not get absorbed from the gut. On this basis the levels reported in milk are unlikely to result from the barium sulphate use as any present in the drilling waste solids should not be absorbed from the gastrointestinal tract of grazing animals.

Barium selenate is used as a registered veterinary medicine for selenium supplement of cattle. This, along with soils ingestion, is a potential contributor to the barium levels reported. Barium levels have been reported in milk in surveys from overseas, these values are detailed in Table 2.

Table 2: Barium levels reported overseas values for whole milk.

Country	Range (mg/kg)
New Zealand	0.09-0.25
France	0.045-0.456[1]
Spain	0.079-0.128[2]
United Kingdom	0.07[3]

1. Millour et al, 2012
2. González-Weller et al, 2013
3. Rose et al, 2010

It is noted from dietary studies that some foods can have exponentially higher levels of barium, for example nuts reported in the UK had 131mg/kg barium (Rose et al, 2010) and Brazil nuts have been reported with levels up to 2000mg/kg (Parekh, 2008).

The range of levels found in the milk from all farms, including the control farms, were 0.086-0.25 mg/kg. There was no apparent elevation in the milk of animals on farms receiving petrochemical wastes when compared to the control farms. The barium levels reported are of negligible risk to public health and reflect a natural background profile. The presence of barium at low levels is most likely to be associated with natural soil levels of barium and also its use as a carrier for selenium in registered veterinary medicines.

The levels observed are consistent with background levels and are not considered to a food safety risk.

5.1.2 Toluene

Toluene is an aromatic hydrocarbon; it is an important industrial chemical and intermediate in chemical synthesis. Toluene may be present in a range of products used in agriculture, including agricultural chemicals, paints and paint thinners. (EHC, 1986)

Toluene may also be produced naturally by some plants, and may occur in pastures as a natural decay product of beta-carotene.

A study in Canada of cows consuming timothy hay indicated that toluene transferred to milk. (Villeneuve et al, 2013). This was indicated as likely being of natural source.

Toluene was detected as present in most of the samples, including 2 out of 3 controls, at consistent levels between 0.011-0.029 mg/kg (parts per million). These results were just above the 0.01 mg/kg limit of detection.

The consistency of detections across the samples with no discernable spikes indicates that the levels of toluene present are not a result of transfer from petrochemical drilling wastes. Also the absence of benzene and xylene is notable as these substances would be expected to be present in petrochemical waste along with toluene, and similarly absorbed if animals are exposed, suggesting that the toluene detected in milk is not likely to be from a petrochemical source.

MPI will not be investigating these finding further at this stage given the minimal level of residues detected, the numerous reports identifying very low levels of toluene in foods and the likelihood that plant based feed is a source.

5.1.3 Longer chain saturated hydrocarbons

Mineral oil saturated hydrocarbons (MOSH) are a group of linear and branched alkanes, they have various uses including in food packaging materials.

The test method utilised by the laboratory separates the mineral oil saturated hydrocarbons into three categories, short chain saturated hydrocarbons (C10 to C16), medium chain saturated hydrocarbons (C17 to C24) and longer chain saturated hydrocarbons (C25 to C35). The hydrocarbons detected in two milk samples relate to a subset of MOSH termed long chain with a backbone of between 25 and 35 carbons. The petrochemical wastes produced in Taranaki are expected to more commonly contain shorter chain rather than longer chain hydrocarbons. No other classes of MOSH or the related mineral oils aromatic hydrocarbons were detected.

MOSH have been assessed by the European Foods Safety Authority (EFSA) who determined a No-Observed-Adverse-Effect-Level (NOAEL) of 19 mg/kg body weight per day from a 90-day toxicity study in rats (EFSA,2012). Because the actual identity of the substance is difficult to establish because they are all complex mixtures, a Tolerable Dairy Intake (TDI) was deemed to be not appropriate.

The results we have seen to date show that MOSH was found in milk intermittently, with most samples having no detectable levels present. The two samples with residues of MOSH had 1.5 and 1.4 ppm in them. MOSH are commonly found in foods (not from landfarms), EFSA estimates the normal exposure is from 0.03 – 0.3 mg/kg body weight per day. The dietary intakes of milk (from the Children's National Nutrition Survey of 2002) for the various age groups show that the highest intake per body weight is for 1 – 3 year old toddlers. At 1.5 ppm MOSH in milk, this gives rise to a dietary intake of 0.03 mg MOSH/kg body weight per day. This dietary exposure is at the low end of the normal intake and is not considered to constitute a food safety risk.

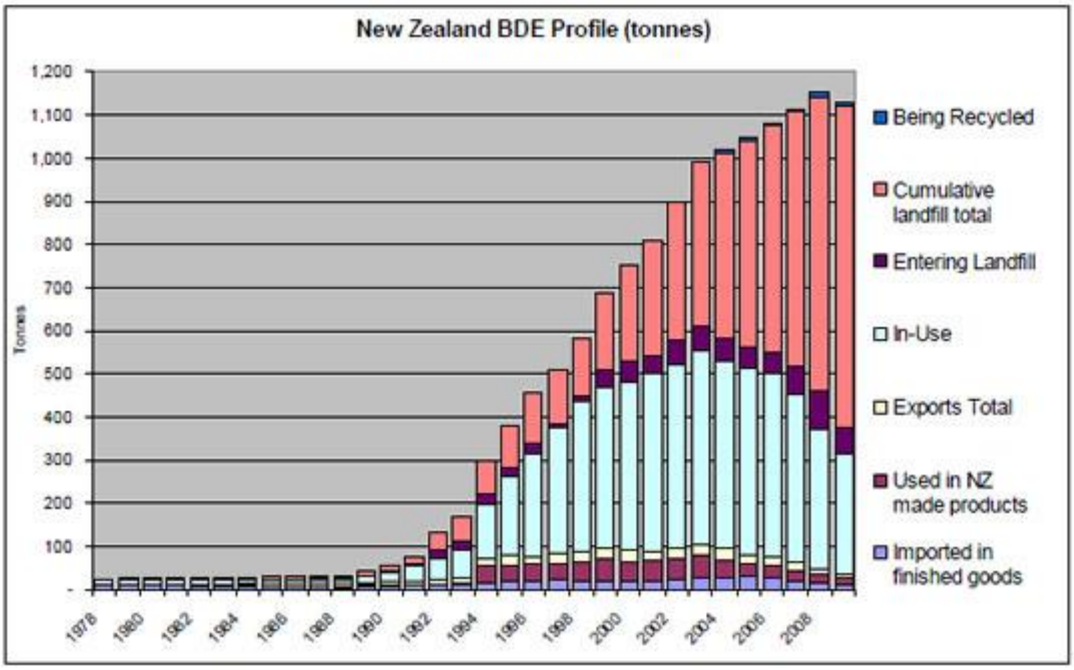
It is possible that the source is from manufactured animal feed which EFSA noted was a recognised potential source for transfer to animal products. Use of veterinary medicines containing saturated hydrocarbons or other farm exposure routes are also possible.

From the NOAEL of 19 mg MOSH/kg body weight per day determined by EFSA, the dietary intake from the two samples with longer chain saturated hydrocarbons there is a margin of exposure of 633 (that is the exposure is over 600 times less than a dose known to have no adverse effects in animal studies).

5.1.4 Polybrominated diphenyl ethers

Polybrominated diphenyl ethers (PBDEs) are a group of chemical compounds utilised in a variety of materials. An MFE commissioned report in 2010 estimated the following profile for PBDEs flow in New Zealand (figure1) which indicates that the level in use have peaked with the majority of PBDEs now in or entering the waste stream.

Figure 1: Profile of BDEs in New Zealand by year (reproduced from Keet et al, 2010)



Due to widespread use around the globe and the ease in which they enter the environment PBDEs are significant environmental contaminants.

Whilst PBDEs or materials containing PBDEs may be in use with the mining industry they also have a range of other sources including dust. With two detections it is not possible to identify that the PBDEs detected in this survey as a result of the use of petrochemical drilling solids. The levels of these are consistent with those reported in other countries. MPI believes it is likely their presence results from environmental exposure or from transfer from other materials that may be in use in agriculture such as plastics.

Only two samples tested positive for trace levels of PBDEs in the chemical monitoring of the milk samples, one from a farm with a landfarm and one from a farm that has had disposal of wastes using the “mix-bury-cover” method. One milk sample contained 2.34ng/kg of BDE#99 and the other contained 2.04ng/kg of BDE#99, 3.73ng/kg of BDE#47 and 0.466ng/kg of BDE#100. PBDE isomers are expected to be used in combination, so the detection of multiple isomers is not significant.

The levels reported from the landfarm sites are within the ranges reported in other countries (Table 3) and fit the isomers profile reported in these surveys, predominantly BDE# 47 and 99.

Table 3: PBDE levels in New Zealand compared to reported overseas values for whole milk.

Country	Range (ng/kg)
New Zealand	Not detected-6.236
Australia	0-73.9[1]
Canada	3.39[2]
Spain	24[3]

1. FSANZ, 2007
2. Health Canada, 2004
3. Bocio et al, 2003

Food Standards Australia New Zealand characterised the dietary risk with PBDEs in the Australian diet in 2007 and concluded that they represented a low risk to Australian consumers (FSANZ 2007). New Zealand would likely share a similar profile of PBDE use to Australia.

5.2 WHAT WE DIDN'T FIND

5.2.1 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs can be expected to be found in fossil fuels (oil and coal) as well as in cooked foods and processed fats and oils. PAHs were a major food safety consideration following the Deepwater Horizon oil spill in the Gulf of Mexico in 2010. The primary 7 PAHs of concern are:

- Benzo[a]pyrene
- Benz[a]anthracene
- Benzo[b]fluroanthene
- Benzo[k]fluroanthene
- Chrysene
- Dibenzo[a,h]anthracene
- Indeno[1,2,3-cd]pyrene

While the presence of PAHs would not be conclusive evidence of exposure to petrochemical wastes (for example, fats and oils in processed feeds could be a potential source), their absence supports the view that the cows have not had significant exposure to these hydrocarbons from any source. Their absence also indicates that other potential exposure routes are not affecting milk.

5.2.2 BTEXS

Due to the potential presence of BTEXS (benzene, toluene, ethyl benzene, xylene (meta-,para), xylene (ortho-) and styrene) the individual compounds in this mixture are considered to be markers for contamination. However only Toluene was detected and, as described under section 5.1 *What We Found,* the source is more likely to be plant based. When considering the nature of the BTEXS and that they share similar chemical properties it would expected that a detection of any one BTEXS would be accompanied by detections in of other BTEXS compounds present in petrochemical waste.

5.2.3 Heavy Metals

Arsenic, mercury and lead were all below the limit of detection. The limit of detection for these elements is also well below any level of concern to public health. All three have the potential to be present in drilling waste.

Vanadium is mainly complexed with sediment and thus represents a good marker for metal contamination in the production waste solids. However vanadium can also occur naturally in soil so is not definite markers of oil. The absence of any detection adds further support to the view that the animals have not been exposed on any measurable level to petrochemical wastes.

5.2.4 Inhibitory Substances

The Inhibitory Substances test is a common antimicrobial test employed by the dairy industry, primarily for the detection of antibiotics. However, the test will also identify other compounds that inhibit growth of the test bacterium at varying levels of sensitivity. There was no indication that any milk sample contained compounds with antimicrobial properties.

5.3 ANALYTICAL TESTING CAPABILITY

The findings in this survey highlight the influence of modern analytical testing methodologies. Several of the compounds and minerals were found at levels at or below 1 part per million (mg/kg), and for some the levels were at or below 1 part per trillion (ng/kg). Sophisticated laboratory instrumental methods have continued to advance, and laboratories are able to detect compounds at levels far below those previously achieved. This trend is expected to continue, and, as it does, we will see more and more compounds in our food which had not been detected previously in that food.

While no compounds and minerals detected in this survey were present at levels that might constitute a possible risk to consumer health, MPI will continue to add to the scientific evidence base that provides ongoing assurance of the safety acknowledges that over time we will gain a better understanding of the makeup of our foods. As we do, it is important that we continue to apply science and base decisions and actions on ensuring the safety of our food.

6 Conclusion

The surveillance study identified that only very low levels of some of the chemical compounds or minerals that were tested for were found and these did not represent a risk to consumers. Further, there was no evidence to suggest that these very limited detections in milk were due to exposure to wastes from petrochemical mining. This conclusion is consistent with the initial assessment and the findings that Fonterra have advised. It also reflects the outcome of bioremediation when undertaken correctly and with animals withheld until the soil has returned to a normal state for grazing.

As milk is a highly sensitive food matrix for identifying the possible presence of chemical hazards, there is no immediate need to conduct further studies for meat.

Farms receiving petrochemical wastes will continue to be included in the MPI national residue monitoring programmes. MPI will also continue to monitor farming activities and take these into consideration when reviewing the content of the various monitoring programmes.

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8 Appendix I: Result Summary

TABLE 4: COMPOUNDS AND MINERALS DETECTED IN FARM MILK

Farm	Compound / Mineral					
	Toluene	Barium	Longer chain saturated hydrocarbons	Polybrominated diphenyl ethers		
			C25-35	#47	#99	#100
	mg/kg	mg/kg	mg/kg	ng/kg	ng/kg	ng/kg
Control Farm: Blenheim	0.017	0.14	< 0.6	<2.5	<1.0	<0.2
Control Farm: Otautau	0.016	0.10	< 0.6	<2.5	<1.0	<0.2
Control Farm: Rotorua	< 0.01	0.14	< 0.6	<2.5	<1.0	<0.2
Farm A	0.024	0.16	< 0.6	<2.5	<1.0	<0.2
Farm B	0.014	0.15	< 0.6	<2.5	<1.0	<0.2
Farm C	0.012	0.17	< 0.6	3.73	2.04	0.466
Farm D	0.026	0.10	< 0.6	<2.5	<1.0	<0.2
Farm E	0.029	0.15	< 0.6	<2.5	<1.0	<0.2
Farm F	0.019	0.18	< 0.6	<2.5	<1.0	<0.2
Farm H	<0.01	0.16	< 0.6	<2.5	<1.0	<0.2
Farm I	0.014	0.22	1.5	<2.5	<1.0	<0.2
Farm J	0.025	0.10	< 0.6	<2.5	<1.0	<0.2
Farm K	0.022	0.25	< 0.6	<2.5	<1.0	<0.2
Farm L	0.019	0.15	< 0.6	<2.5	<1.0	<0.2
Farm M	0.014	0.17	< 0.6	<2.5	<1.0	<0.2
Farm N	0.020	0.17	< 0.6	<2.5	<1.0	<0.2
Farm O	0.013	0.17	< 0.6	<2.5	<1.0	<0.2
Farm P	0.011	0.14	1.4	<2.5	<1.0	<0.2
Farm Q	0.019	0.14	< 0.6	<2.5	<1.0	<0.2
Farm R	0.014	0.09	< 0.6	<2.5	2.34	<0.2

TABLE 5: MINERALS AND COMPOUNDS NOT DETECTED IN ANY FARM MILK

Compound	Units	Limit of Detection	Compound	Units	Limit of Detection
Acenaphthene	ng/g	0.25	BDE# 7	ng/kg	0.2
Acenaphthylene	ng/g	0.25	BDE# 71	ng/kg	0.2
Anthracene	ng/g	0.5	BDE# 77	ng/kg	0.2
Antimony	mg/kg	0.01	BDE# 85	ng/kg	0.2
Arsenic - (inorganic)	mg/kg	0.01	Benz[a]anthracene	ng/g	0.25
BDE# 119/120	ng/kg	0.2	Benzene	mg/kg	< 0.01
BDE# 126	ng/kg	0.2	Benzo[a]pyrene	ng/g	0.25
BDE# 138/166	ng/kg	0.5	Benzo[b]fluoranthene	ng/g	0.25
BDE# 139	ng/kg	0.5	Benzo[g-h-i]perylene	ng/g	1
BDE# 140	ng/kg	0.5	Benzo[k]fluoranthene	ng/g	0.25
BDE# 15	ng/kg	0.2	Dibenz[a,h]anthracene	ng/g	1
BDE# 153	ng/kg	0.5	Chrysene	ng/g	0.1-1
BDE# 154	ng/kg	0.5	Decabromodiphenylethane	ng/kg	20
BDE# 156/169	ng/kg	0.5	Ethyl benzene	mg/kg	< 0.01
BDE# 17	ng/kg	0.2	Fluoranthene	ng/g	0.25
BDE# 171	ng/kg	1	Fluorene	ng/g	0.25
BDE# 180	ng/kg	1	Fluoride	mg/kg	1
BDE# 183/175	ng/kg	1	Hexabromobenzene	ng/kg	0.5
BDE# 184	ng/kg	1	Hexabromobiphenyl	ng/kg	0.5
BDE# 191	ng/kg	1	Indeno[1,2,3-cd]pyrene	ng/g	1
BDE# 196	ng/kg	2	Lead	mg/kg	0.01
BDE# 197	ng/kg	2	Mercury- (Total)	mg/kg	0.005
BDE# 201	ng/kg	2	MOAH C10-C35	ng/g	< 0.15
BDE# 203	ng/kg	2	MOSH medium chain C17-24	mg/kg	< 0.6
BDE# 204	ng/kg	2	MOSH short chain C10-16	mg/kg	< 0.6
BDE# 205	ng/kg	5	Naphthalene	mg/kg	1
BDE# 206	ng/kg	2	Pentabromoethylbenzene	ng/kg	0.2
BDE# 207	ng/kg	2	Phenanthrene	ng/g	0.5
BDE# 208	ng/kg	2	Pyrene	ng/g	1
BDE# 209	ng/kg	20	Styrene	mg/kg	< 0.01
BDE# 28/33	ng/kg	0.2	Vanadium	mg/kg	0.01
BDE# 30	ng/kg	0.2	Xylene-meta & -para	mg/kg	< 0.01
BDE# 49	ng/kg	0.2	Xylene-ortho	mg/kg	< 0.01
BDE# 66	ng/kg	0.2			

TABLE 6: COMPOSITIONAL RESULTS

Farm	Constituent				
	Milkfat % w/v	Protein % w/v	Lactose % w/v	Total Solids % w/v	Freezing Point Depression Deg C
Control Farm: Blenheim	4.20	3.89	4.73	13.46	-0.522
Control Farm: Otautau	6.74	4.29	4.22	16.02	-0.485
Control Farm: Rotorua	6.78	4.97	4.64	17.13	-0.530
Farm A	7.15	4.70	4.59	17.23	-0.528
Farm B	6.99	4.81	4.56	17.16	-0.532
Farm C	7.65	5.11	4.57	18.18	-0.530
Farm D	7.50	4.84	4.61	17.78	-0.538
Farm E	8.02	5.01	4.69	18.59	-0.535
Farm F	5.40	4.12	4.76	14.94	-0.523
Farm H	5.45	3.59	5.01	14.69	-0.524
Farm I	5.45	3.93	4.78	14.83	-0.521
Farm J	6.77	4.63	4.74	16.88	-0.529
Farm K	7.01	4.64	4.35	16.76	-0.511
Farm L	5.69	4.20	4.78	15.36	-0.525
Farm M	6.21	4.45	4.56	15.94	-0.527
Farm N	5.94	4.48	4.65	15.77	-0.524
Farm O	6.93	5.00	4.48	17.26	-0.519
Farm P	5.06	3.53	4.99	14.29	-0.523
Farm Q	5.95	4.29	4.74	15.66	-0.523
Farm R	5.52	4.03	4.78	15.02	-0.524