Call for Information on use of hydrogen cyanamide substances – Response on behalf of the New Zealand kiwifruit industry

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Response to Call for Information on hydrogen cyanamide substances	
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Part 1: Manufacture and import volumes

1a) Do you have any information on the quantities of hydrogen cyanamide-containing substances that are manufactured or imported into New Zealand annually?

NO

1b) If your answer is yes, please provide information relating to the quantities of hydrogen cyanamide-containing substances imported and/or manufactured annually in the space below or as a separate attachment.

Information may include data on the quantities of hydrogen cyanamide-containing substances being formulated here or imported into the country.

1c) Do you hold any New Zealand sales data for any of the hydrogen cyanamide-containing substances?

NO

1d) If your answer is yes, please provide the sales information in the space below or as a separate attachment.

1e) Do you hold any New Zealand use data for any of the hydrogen cyanamide-containing substances?

NO

1f) If your answer is yes, please provide the sales information in the space below or as a separate attachment.

Part 2: Packaging and trade name information

Suggested responders: importers, manufacturers, suppliers, retailers

2a) Do you have any information on the trade name substances containing hydrogen cyanamide, and their corresponding HSNO approval numbers?

NO

2b) If your answer is yes, please provide this information in the space below.

2c) Do you have any information on how these hydrogen cyanamide-containing substances are packaged?____

NO

2d) If your answer is yes, please provide information relating to how the substances are packaged for sale / distribution

Part 3: Use and application information

We are seeking information on how hydrogen cyanamide-containing substances are used in the agricultural sector in New Zealand. We are seeking information on the use patterns for different crops, the prevalence of use for each crop type, and whether this use corresponds with a particular product label or is an off-label use.

3a) Do you have any information on how hydrogen cyanamide-containing substances are used in the agriculture sector in New Zealand?

YES

3b) If your answer is yes, please provide this information in the space below.

A. Use of Hydrogen cyanamide in kiwifruit

Hydrogen cyanamide (HC) is a flower-inducing dormancy-breaking compound and is critical for kiwifruit production where it is used in late winter primarily to compensate for inadequate winter chill. HC is also used to condense flowering, promote uniform budbreak and reduce unwanted lateral flowers even in regions which don't need to compensate for lack of winter chill.

Budbreak is a part of a kiwifruit vine's growth cycle and signals the end of dormancy after the winter. Budbreak occurs in the spring. Over the winter, the vine has been dormant with very little growth or activity within the plant, but as the temperature increases in the spring, the vine begins its growth cycle for the new growing season. The first visible indication that the plant is leaving dormancy is when sap is seen dripping from pruning wounds. Next, buds grown the previous spring begin to fluff and then swell and open. Leaves and flower buds develop rapidly. After pollination, these flowers turn into fruit.

Without the use of HC, the impact on yield will be so significant (particularly for Hayward) that growing the crop is likely to become uneconomic for some growers as returns will not cover growing costs. HC ensures adequate and consistent yields and reduces labour and quality costs, allowing growers to achieve economic returns.

HC is allowed for use on Zespri-supplying conventional (i.e. not organic) orchards and is not used on organic kiwifruit orchards. Organic kiwifruit is expected to make up around 2.69 percent of Zespri's NZ volume in the 2020 season.

B. Application quantity and timing

HC is applied to vines once a year in dormancy to enhance budbreak at a product rate of 6% per 100 L (HC approx 3.12 kg/100L or 21.84 kg/700L). HC is tank-mixed with drift-reducing adjuvant at a rate between 150 and 250mL/100L, in line with industry recommendations for drift management.

Under Zespri GAP, based on the international GLOBALG.A.P. standard, all foliar agrichemical applications must be recorded in a spray diary which is audited before Zespri gives the grower clearance to pick fruit from that orchard.

Data from spray diaries submitted by growers to Zespri from 2016 through 2019 shows that on average 86% of conventional hectares are treated with HC. Last season 11,543ha were sprayed and more hectares are being brought into production. The use of HC remains relatively consistent across conventionally-grown varieties: Zespri Green (Hayward), Zespri SunGold (Gold3) and Zespri Red.

Spraying of HC occurs over a six-week period (29 July through to 8 September) with 91% of all hectares sprayed over ISO weeks 32, 33 and 34.

Table 2: GAP table extracted from Australian Environmental Agency Pty Ltd (2020)
Kiwifruit: Hydrogen cyanamide – based on Hi-Cane 520 g/L hydrogen cyanamide formulation (soluble concentrate)

Crop and/or situation (a)	Use pattern (b)	Pests or group of pests controlled (c)	Mixture		Application				Application rate per treatment	
			Type (d-f)	Conc of a.i. (g)	Method and kind (h-i)	Growth stage & season (j)	Number Min max (k)	Interval between applications – days (minimum)	water L/ha min max	kg a.i./ha max
Kiwifruit	Field	Plant growth regulator	Suspension concentrate	520 g/L	High volume ground spraying	Dormant vines (prior to bud break)	1	-	Mature vines 500-700 DO NOT exceed 800	(Apply 4-6 L Hi-Cane/100 L water) 10.4-15.6 (500 L spray/ha) 14.6-21.8 (700 L spray/ha) 16.6-25.0 (800 L spray/ha)

a Where relevant, the use situation should be described (e.g. fumigation of soil)
b Outdoor or field use (F), glasshouse application (G) or indoor application (I).
c e.g. Biting and sucking insects, soil borne insects, foliar fungi, weeds
d e.g. Wettable powder (WP), emulsifiable concentrate (EC), granule (GR)
e CropLife international, 2008. Technical Monograph no 2, 6th edition. Catalogue of pesticide formulation types and international coding system
f All abbreviations used must be explained
g g/kg or g/l or others
h Method, e.g. high volume spraying, low volume spraying, spreading, dusting, drench, aerial, etc
i Kind, e.g. overall, broadcast, aerial spraying, row, individual plant, between the plant - type of equipment used must be indicated. If spraying include droplet size spectrum
j Growth stage at last treatment (BBCH Monograph, Growth Stages of Plants, 1997, Blackwell (ISBN 3-8263-3152-4), including where relevant, information on season at time of application
k Indicate the minimum and maximum number of application possible under practical conditions of use

C. Summary of hydrogen cyanamide registrations on plants in other countries

All uses as a plant growth regulator for stimulation of uniform budbreak.

Country	Crops and Rate ai / 100L water	Controls
NZ (current) e.g. Hi-Cane	Kiwifruit 2.08 – 3.12 L ai /100L 500-700L/ha (max 800L/ha) Apples 1.3 L ai /100L 800 – 1300L/ha	Approved handler. Tracked at all times. Keep dogs + other animals away when spraying and after spraying (3 days for non-grazing animals and 7 days for grazing animals). Do not apply this product in a manner that will directly, or through drift, expose workers or other persons. Remove unprotected persons from the operating area. Avoid contact with skin and eyes and avoid breathing spray mist. When mixing or applying wear full PPE such as spray suit or leggings, elbow length PVC gloves, boots, eye protection and a NIOSH approved respirator with combination filter for vapour / particles. Where workers are in contact with canes within 5 days of spraying, gloves should be worn. Instructions stating to not use the product off-label are advice from the manufacturer rather than as a result of legislative requirements (i.e. none of the products have ACVM condition 31 or 87, which precludes off-label use).
Australia	Kiwifruit 2.21 – 3.18 L ai / 100L Apples 1.06 – 1.59 L ai /100L Grapes 1.06 – 2.65 L ai / 100L Almonds & walnuts 1.04 L ai /100L Plums and prunes 0.52 L ai/100L *[Min / max water rate not stated]*	Wear cotton overalls buttoned to neck and wrist and washable hat, elbow length PVC gloves and face shield or goggles. Label directions mandatory. Add wetting agent.
USA	Kiwifruit 2 L ai /100L max 935L water / ha Apples & Cherries 1L ai / 100L max 1,870L water /ha Blackberries & Blueberries 1.5 - 3L ai/ 100L 468 - 935L water /ha Grapes 2 L ai /100L max 935L water /ha Peaches / nectarines 0.25 – 0.37 ai / 100L max 1,870L water /ha	Restricted use due to corrosive effects on eyes and skin. Use by certified applicators. PPE protective suit, gloves, footwear + socks, eyewear. Persons who mix, load or transfer must wear goggles/safety glasses or full face shield. Chemical resistant headgear for overhead exposure + apron when cleaning equipment, mixing or loading. Respirator with either an organic vapor removing cartridge with a prefilter approved for pesticides or a canister approved for pesticides. Engineering controls: closed systems - product must be mixed, loaded and transferred only in a closed system. Applied only with the applicator in an enclosed cab. PPE may be reduced or modified as specified in the worker protection standard. Operating pressure max 40psi with the use of low pressure nozzles on dilute boom sprays and max 100 psi on airfan sprayers. Air fan should have fan adjusted so spray mist does not greatly exceed top vines being sprayed. Do not apply in any area where endangered species have been identified or in a manner that drift could destroy endangered species. Do not apply closer than 274m to the mean high water mark for intertidal areas or surface water. Do not apply to crops growing closer than 274m to rivers, streams or their flowing tributaries. Do not apply this product in a way that

Country	Crops and Rate ai / 100L water	Controls
		will contact workers or other persons – either directly or through drift. Only protected handlers or protected supervisors maybe in the area during application. During application no person shall be within 92m of the area to be treated unless involved in mixing or loading. Aerial application prohibited. REI 72 hours. PPE early re-entry that involves contract with treated area e.g. plants / soil water is suit, gloves, foot + eye wear. Notify workers of the application orally or via warning signs at entrances. Coarse sprays pressure max 40psi for dilute boom and 100psi for air fan sprayers and spray only to wet. Do not exceed 37L/ha. Do not use nozzles that promote fine spray droplets. Can contaminate surface water through ground spray applications. Potential for run off into surface water after applications including poorly drained or wet soils with readily visible slopes towards adjacent surface waters, frequent flood areas, areas overlaying shallow ground water, areas that drain into surface water, areas not separated from adjacent surface waters by vegetated filter strips, and areas overlaying tile drainage systems that drain to surface water. Highly toxic to freshwater invertebrates and moderately toxic to birds and mammals. Drift and runoff may be hazardous to aquatic organisms in neighboring areas. Label directions mandatory.
Greece (temporary registration)	Kiwifruit 9.36 L ai /ha 1.56 L ai / 100L spraying liquid Water rates Tractor spray- 400- 600L Motorized sprayer 400-500L water/ha	Do not breath mist or vapours. Wear protective gloves, clothing, eye and face protection. Wear PPE for eyes and face, chemical-resistant protective suit, boots and hat during the preparation, loading and spraying. Avoid spray drift, spraying pressure should not exceed 3 atm. Spraying should only take place when in still air conditions.
Chile	Kiwifruit 1.56L ai / 100L 1,000 - 1,500L water / ha In other situations, 2.6L ai / 100L with a nebulizer in 600 - 700L water / ha Pear 1.56L ai / 100L 1,000 to 1,500L water / ha Grapes 2.6L ai / 100L 800 -1,500L water / ha on trellises 300 - 800L water / ha Apple 0.78L ai / 100L	PPE rubber gloves and boots, waterproof apron and overalls, face protector. During application wear rubber gloves and boots, waterproof apron and overalls and face shield. For the safety of the operator, it is recommended this product is applied only with rod or nebuliser equipment. Keep pets and bystanders away. **Environmental risks:** toxic to fish and bees, moderately toxic to birds. **Re-entry** 4 hours to carry out work on treated plants, use gloves for up to 5 days after application.

Country	Crops and Rate ai / 100L water	Controls
	1,000 – 1,500L water / ha Plum / walnut 1.04L ai / 100L 1,000 – 1,500L water / ha Blueberries, Raspberries 0.78 – 1.56L ai / 100L 400- 1,000L water / ha	
Italy	Registration pending 2020.	Details not yet available
Common controls on all labels = warnings about consuming alcohol, control spray drift, contamination of water, protection of bees / Do not spray while bees actively foraging.		

Part 4: Exposure mitigation measures

Suggested responders: importers, manufacturers, suppliers, applicators, users, growers (including industry groups), other affected parties

We are seeking information on any exposure mitigation measures that are currently being used to limit environmental or human exposure for substances containing hydrogen cyanamide.

This should include details of industry practices that are required to be followed as part of an industry-led approach to risk management. We would like to know whether any measures additional to the requirements are currently being prescribed to minimise environmental or human health exposure (such as adherence to the Management of Agrichemicals New Zealand Standard NZS8409:2004, or requirements arising from other legislation (for example: Health and Safety at Work Act 2015, Resource Management Act 1991)).

4a) Do you have information on how exposure risks associated with hydrogen cyanamide substances are managed/ mitigated?

YES

4b) If your answer is yes, please provide examples of exposure mitigation measures that are implemented for safe application of these substances.

A. Current Mitigation Measures – Regulatory

Growers and applicators are required to adhere to regulatory requirements including the product label, regional air plans and additional measures under the Health and Safety at Work Act, in line with WorkSafe guidance. The Zespri GAP system also requires growers to comply with any local, regional or national regulatory requirements.

Label regulatory requirements (based on Hi-Cane)

Applicators follow the mitigation methods for both the environment and human exposure as described on the label. Using Hi-Cane as an example, these requirements include (but are not limited to):

- Managing spray drift
- Wearing specified PPE
    - Avoid contact with skin and eyes and avoid breathing spray mist.
    - When mixing or applying wear full protective clothing such as a PVC spray suit or leggings, elbow length PVC gloves, boots, eye protection and a NIOSH-approved respirator with combination filter for vapour / particles.
- Removing bystanders from the area before spraying
- Observing the Restricted Entry Interval (REI) of 5 days and if entering before then – requiring persons to wear gloves
- Hygiene measures including not eating, drinking or smoking while using the product and removing PPE before consuming meals and after work has completed and washing clothing
- Observing tracking, handling and storage requirements
- Avoiding contamination of waterways with product or empty container
- Keeping animals including dogs and stock clear when spraying or washing tank
- Application equipment must be appropriate, correctly calibrated and well-maintained so that it does not leak, and it should dispense the product at the rate it is designed for. Use and maintenance documentation must be readily available for workers.
- Triple-rinsing containers and recycling. Isolating any spills, absorbing with inert material into waste containers.

Air plan requirements

Regional councils around New Zealand are responsible for regulating some aspects of agrichemical use which are generally managed through air plans. While each region differs, key elements of these include:

- Growers must ensure the potential for drift beyond the boundary is limited and that no adverse events arise
- Growers must ensure applicators have appropriate training and applicators must hold a current GROWSAFE Certificate (or equivalent)
- Application should be undertaken in accordance with NZS8409 (i.e. adhering to provisions around correct use, storage including specifying conditions to avoid, disposal and records etc).
- Product must be disposed of correctly through an appropriate means such as Agrecovery, and not dumped.
- Growers meet notification requirements to occupiers of nearby properties
- Growers must adhere to signage requirements when spraying
- Some councils require that growers have an annual spray risk management plan and identify sensitive areas

WorkSafe requirements

Growers must mitigate exposure risk to human health and safety from using, handling and storing agrichemicals and must take all reasonably practicable steps to ensure the health and safety of workers and other persons who could be put at risk by the growing operation.

This requires that growers also:

- Ensure ignition sources are not near the product
- Ensure correct PPE is available and worn
- Observe the REI
- Hold the safety data sheet (SDS) in the inventory of hazardous substances and make sure it is available to all workers using the substance
- Keep an accurate written record of each application for at least 3 years including the product name, date and time of each application, the amount applied, the location, a description of the wind speed and direction when the product was applied, the name of the worker using the product and address of the workplace
- Ensure equipment used to handle and apply the product is appropriate and accompanied by documentation about the use and maintenance of the equipment. The documentation is made available and understandable to any worker handling the product
- Observe transportation rules around carrying the product
- Establish hazardous substance locations where required depending on the volume stored.
- Comply with signage (including any local requirements), location, emergency response, storage and tracking requirements and record keeping, implementing appropriate separation distances from stores to protected places depending on quantities
- Consider the nature of the work to be carried out including the risks of exposure and the likely degree of exposure to the product and identify necessary precautions above those specified by regulation that need to be put in place

B. Current mitigation measures – required by industry

Zespri has developed a set of Good Agricultural Practice requirements that all growers must comply with, underpinned by the GLOBALG.A.P certification standard. Zespri requires all growers to comply with GLOBALG.A.P, all legislated requirements including regional plans and Zespri best practice and customer requirements (referred to as Zespri GAP).

Zespri GAP reflects the industry's our commitment to protecting the environment, including the quality of our water, air and soils for current and future generations and also supporting and protecting our communities. The Zespri GAP programme is certified by accredited certification bodies (through the Joint Accreditation System of Australia and New Zealand (JAS-ANZ). All growers are audited for compliance to Zespri GAP by approved inspectors prior to each growing season.

To be exported by Zespri, all kiwifruit must be grown in accordance with the Zespri Crop Protection Standard. Zespri's Crop Protection Standard aligns with all registered use patterns and specifies the controls that must be used when applying HC to kiwifruit orchards.

Zespri GAP requires all growers to comply with the use pattern specified on the label for HC products and adds an additional layer of controls relating to on-orchard practices. These include:

- all applicators must hold a current GrowSafe certificate
- applications of HC must be done using AI nozzles and drift reducing adjuvant
- only one application is allowed during dormancy only at 4-6L/100L
- Site risk assessments to identify and mitigate risks associated with fruit production including environmental, health and safety (operator and bystander), food safety, labour, and security risks.
- Requirements to maintain records to verify compliance
- Growers and contractors must be able to demonstrate competency in the storage, handling and application of agrichemicals
- Must have a documented spray plan that identifies risks by undertaking a site risk assessment and identifies mitigations that will address identified risks.

Zespri carries out multi-residue tests on all supplying orchards. This ensures compliance with agrichemical application requirements and highlights areas of non-compliance, and identifies training and communication needs. Before accepting fruit, Zespri audits all spray diaries and reviews all residue results for compliance with the Zespri GAP programme. Growers must pass these checks and have a successful GAP audit before they can supply kiwifruit to Zespri.

Drift reduction

One of the major sources of risk when spraying HC is spray drift which occurs when the spray moves away from the target area. It can be a risk if it comes into contact with non-target areas. In general, all size classes of spray droplets can move off target, but the smaller drops are likely to move the farthest before depositing on the ground or a non-target area. Droplet size is probably the single most important factor controlling spray drift.

Air induction nozzles and DriftStop

The use of air induction (AI) nozzles produces large, air-filled, coarse droplets which are less likely to be picked up by air movement and drift offsite. AI nozzles therefore substantially reduce the risk of spray drift. Drift-reducing adjuvants, such as DriftStop™, further reduce this risk by reducing the percentage of very small driftable droplets within the spray mix. Along with drift control, DriftStop™ is designed to improve adhesion of large droplets and to improve their spread (coverage) on cane surfaces.

A number of trials (Gaskin et al. 2006, Gaskin & Manktelow 2007, 2008, Gaskin et al. 2008, 2014) have explored drift reduction, spray coverage and biological efficiency of HC applications using AI nozzles. These studies demonstrated that drift is significantly reduced by the use of AI nozzles with a drift-reducing adjuvant (DriftStop™).

Zespri has required all growers to apply HC using AI nozzles plus a drift-reducing adjuvant, such as DriftStop™ since 2011 as part of Zespri GAP. Following 2013 research that showed that increasing DriftStop™ rates improved drift control, rainfastness, drying time and absorption, it was recommended that growers look to increase the rate of DriftStop™ to 250 mL/100 L. Under these conditions, a typical grower will spray (using an air blast sprayer with AI nozzles) 6% of the formulated product at 600-700 L/ha with the addition of DriftStop™ adjuvant at 0.2%.

AI nozzles in combination with drift-reducing adjuvants typically reduce downwind losses over 9m from the sprayer by 85%[1] compared to the previous standard, hollow cone nozzles. Research in 2018 found that approximately 2% of the applied mass of product sprayed may leave as spray drift using this system (AI nozzles + drift reducing adjuvants). The use of other drift-reducing techniques can further reduce the risk of off-target spray drift.

The use of AI nozzles is recorded in each grower's spray diary (which records all foliar-applied agrichemicals and products) and the Zespri GAP audits include a check that AI nozzles are used.

Best practice guidance

Zespri produces guidelines on good spray practice, including some specific to HC applications, which are communicated to industry through several channels including:

- Publications (regular printed and electronic newsletters, one-off booklets, journals etc)
- Grower forums (field days, seminars, workshops)
- Dedicated areas on the Zespri grower website (canopy.zespri.com)
- Industry technical forums (post-harvest technical staff, key retailers, consultants etc)

The key resource for spraying hydrogen cyanamide is the *Support for Safe Spraying* booklet (available on request). Topics include:

- Knowing the criteria to meet under Zespri GAP and your regional plan
- Preparation of an annual spray plan
    - Identifying areas of risk around and within the orchard
    - Completing a risk assessment
    - Identifying actions to minimise adverse effects on spray sensitive areas (see below)
- Notification
- Signage
- Monitoring and preventing drift
- Setting up sprayers
- Using AI nozzles to reduce drift

The best practice guidelines includes specific suggestions risk mitigation measures including:

- Considering the direction of travel in the orchard
- Turning off nozzles facing a sensitive area
- Weather conditions, in particular speed and direction of wind
- Use of contractors for HC applications on higher risk sites
- Installation of shelter
- Managing air volumes from sprayers

[1] Gaskin, R.E., Manktelow, D.W.L. & Steele, K.D. 2006. *Adjuvant and application technologies to minimise off-target drift from kiwifruit sprays*. New Zealand Plant Protection, 59: 217-222

Community engagement
For the past 10 years, NZKGI and Zespri have distributed brochures for the wider community about safe spraying practices, particularly as it relates to HC. It lets the community know about their rights and the responsibilities kiwifruit growers have to keep their communities safe. This brochure is delivered to all Rural Delivery addresses in Bay of Plenty and last year was also distributed to Rural Delivery addresses in Kerikeri. This is backed up with public relations outreach in local media.

In Kerikeri in 2019, the industry also undertook a campaign to raise awareness in the community with advertisements, PR and public meetings, as well as hosting a stall in the local markets to answer questions and engage positively with the local community.

NZKGI runs a hotline to answer spraying questions from the public and follow up on complaints. Zespri's grower liaison team also proactively identifies orchards in sensitive locations – e.g. near schools or public walkways – and works with the growers to ensure they have steps in place to mitigate spray drift during HC application season.

4c) Do you have information that indicates how effective the exposure mitigation measures are in regards to management of adverse effects arising from use of hydrogen cyanamide substances?

YES

4d) If your answer is yes, please provide this information in the space below. Please feel free to also attach any product labels.

C. Proposed Mitigation Measures

NZKGI commissioned a quantitative risk assessment from Australian Environment Agency Pty Ltd. This is attached as an Appendix A and is to be kept strictly confidential to EPA.

In Section 5f below, a summary of the independent risk assessment is provided. The risk assessment includes the baseline assumption that AI nozzles and Driftstop are compulsory, as this is already an industry requirement for Zespri-supplying orchards. Additional information on this assumption follows.

AI nozzles and Driftstop

The raw data provided to Australian Environmental Agency Pty Ltd for the toxicology assessment was developed through a Zespri Innovation project. The trials were conducted by Plant Protection Chemistry New Zealand.

The preliminary study confirmed that AI nozzles could provide major benefits for reducing spray drift. The subsequent field laboratory studies further confirmed these new nozzle and adjuvant technologies could improve application practices for HC sprays on kiwifruit.

Detailed methodology can be found in Gaskin, *et al*. (2006a and 2006b). Raw data is available upon request.

Gaskin, R.E., Manktelow, D.W.L. & Steele, K.D. 2006. *Adjuvant and application technologies to minimise off-target drift from kiwifruit sprays*. New Zealand Plant Protection, 59: 217-222
Gaskin, R.E., Manktelow, D.W.L. & Steele, K.D. 2006. *Improved hydrogen cyanamide application strategies: Final report to Zespri,* project number MA0621.

Shelter belts

The industry compliance programme Zespri GAP requires growers to mitigate spray drift and shelter belts are one tool growers can use to do this. Zespri has published a guide to safe spraying which advises growers that shelter is an important risk management tool and provides advice on how it should be used.

Growers are advised that where shelter is not able to be installed or is insufficient to manage risks from spray drift, then alternative risk mitigation is required. As part of their spray plan required by Zespri GAP, all growers must identify the risk of spray drift and specify how the risk will be managed. This is audited as part of the Zespri GAP programme. Most growers utilise shelter as their primary risk mitigation tool. Management of spray drift is also required by regional council air plans.

It is understood that risk assessment methodology is not able to model the extent to which shelter mitigates risk even though it is extremely effective.

Proposed mitigation

The risk assessment completed by Australian Environmental Agency Pty Ltd (Appendix A) summarised in Section 5f, identifies the following risks and mitigation. This assumes AI nozzles and Driftstop are compulsory.

Acceptable risks – no additional mitigation required

- Groundwater
- Risk to birds

Risk requiring mitigation

- Environmental risk
    - Aquatic risk from drift – mitigated by downwind buffer zone of 6m
    - Aquatic risk from runoff – mitigated by downslope buffer zone of 14m

- Human health risk
    - Bystander – mitigated by downwind buffer zone of 8m
    - Operator – mitigated by PPE

The industry considers that while risk modelling indicates downwind buffer zones may be required for bystander and aquatic risk, this does not take into account the additional risk mitigation provided by shelter. Shelter is strongly recommended to growers and if not used, alternative risk mitigation must be documented.

We also believe the regional council and industry requirements for notification and signage further mitigate the risk to bystanders.

Therefore, in addition to current requirements, we propose the following specific risk mitigation measures be applied for the continued used of HC in kiwifruit:

- Full PPE (coveralls, a washable hat, chemical resistant gloves and a respirator) for mixing, loading and application
  or
  Enclosed cab application
- Requirement to use AI nozzles and drift retardant when applying.

When combined with the industry requirements and regional council requirements, these measures will be sufficient to mitigate environmental and human health impacts from the continued use of HC.

Part 5: Scientific and technical information

Suggested responders: importers, manufacturers, suppliers, industry groups, other affected parties.

5a) Do you have any studies or technical reports on the toxicology of hydrogen cyanamide or its formulations (either published or unpublished reports)?

YES

5b) If your answer is yes, please provide these as attachments.

An independently-prepared risk assessment report is attached as Appendix A.

5c) Do you have any studies or technical reports on the ecotoxicology of hydrogen cyanamide or its formulations (either published or unpublished reports)?

YES

5d) If your answer is yes, please provide these as attachments.

An independently-prepared risk assessment report is attached as Appendix A.

5e) Do you have studies or technical information on the environmental fate of hydrogen cyanamide or its formulations (either published or unpublished reports)?

YES

5f) If your answer is yes, please provide these as attachments

NZKGI commissioned a quantitative risk assessment from Australian Environment Agency Pty Ltd. This is attached as an Appendix A and is to be kept strictly confidential. The outcomes from this assessment have been initially modelled to follow the methodology detailed in the EPA's Risk Assessment Methodology for Hazardous Substances document (January 2020).

In some instances, these have been further refined using real world information in place of default assumptions, to better represent use in the New Zealand context. Similarly, most of the endpoints are from EFSA's 2010 and US EPA's 2016 reports but where deviations from these occur, rationale is provided. An example of this is the dermal absorption factor for which the value accepted by the US EPA is used, rather than the NZ EPA's default values.

A. Human health

The commissioned independent risk assessment shows the primary source of risk to operators is via dermal, rather than inhalation exposure for mixing, loading and application. Unsurprisingly, measures that reduce dermal exposure to operators, result in the greatest reduction to risk quotients.

Exposure to operators is reduced to acceptable levels so long as mixing and loading is done with:

- the operator wearing coveralls over clothing, chemical resistant gloves, a hat and a respirator of PF10 or better

and that the application is done with:

- the operator wearing coveralls over clothing, with chemical resistant gloves, a hat and a respirator of PF10 or better

or

- that application is using an enclosed cab.

Spray applicators already wear appropriate PPE to safely apply HC so we propose making full PPE including respirators compulsory for mixing, loading and applying, unless HC is applied using an enclosed cab sprayer.

Bystander exposure risk was also modelled as part of the independent assessment and is considered acceptable if a downwind buffer zone of 8m is observed. As discussed in Section 4d, industry considers it has adequate risk mitigation measures in place including shelter, notification and signage and this buffer zone is not required.

B. Environmental risk

A risk assessment focusing on aquatic invertebrates and terrestrial vertebrates (birds) was also conducted.

Aquatic

The independent risk assessment report takes the methodology used by the NZ EPA for aquatic risk assessment and refines it to reflect real-world measurements of spray drift measured by Zespri using AI nozzles and drift retardant on dormant vines.

This demonstrated spray drift is similar to, but less than, the default values in the NZ EPA's vineyard scenario. The sparse orchard scenario is inappropriate as it consistently overestimated drift by about 30 times. A downwind buffer zone of approximately 6m is proposed to reduce spray drift exposure below the level of concern for threatened species, assuming that there are no shelter belts in place. As discussed in Section 4d, industry considers best practice regarding installation of shelter mitigates this risk and no buffer zone is required.

Refinements were also made using real world slope data to refine the run-off risk assessment. The risk assessor has concerns regarding the validity of the fixed defaults of 100mm rainfall and 20mm runoff in the model being valid parameters and consider them likely too high. This model shows that a downslope buffer zone of 14m would be required to reduce exposure below the required level of concern for threatened species. Given the uncertainty in the modelling reflecting real world risk, we do not believe a downslope buffer zone is required.

A groundwater risk assessment using modelling for a worst-case scenario demonstrates a PEC well below (0.0027) the level of concern of used by the EU for the maximum permissible concentration of pesticide active ingredients and their metabolites (0.1 µg/L). This indicates any risks arising from groundwater concentrations of HC building up are negligible.

Birds

After conducting a refined risk assessment for birds accounting for the timing of application and the degradation of cyanamide, short term risks to birds are demonstrated to be acceptable. This is supported by field evidence which is described in Appendix A of the risk assessment.

Incorporating telemetry data into this assessment shows birds spent on average 21% of their time in the fields of application brings the chronic risk quotients below the Level of Concern (0.05 to 0.06 against an LOC of 0.1) for threatened species if it is assumed that zero crop interception will occur – in reality there will still be some crop interception despite the dormant state of vines. No risk mitigation is required to manage risk to birds.

As discussed in Section 4b, in addition to current requirements, we propose the following requirements for **loading and mixing**:

- the operator to wear coveralls over clothing, chemical resistant gloves, a washable hat and a respirator of PF10 or better

And for **application**:

- The operator to wear coveralls over clothing, chemical resistant gloves, a washable hat and a respirator of PF10 or better
  or
  Enclosed cab application
- Requirement to use AI nozzles and drift retardant when applying

5g) Do you have any environmental monitoring data on the presence of hydrogen cyanamide in the New Zealand environment?

NO

5h) If your answer is yes, please provide these as attachments

Part 6: Impacts on Māori associated with use of hydrogen cyanamide

Suggested responders: kaitiaki, iwi, hapū, importers, manufacturers, suppliers, applicators, users, growers (including industry groups), other affected parties

We are seeking information on the positive or adverse impacts on the relationship of Māori and Māori culture to the environment associated with use of hydrogen cyanamide-containing substances.

6a) Do you have any information regarding the impacts of hydrogen cyanamide-containing substances on the environmental, economic, social and cultural well-being of Māori?

This includes any impacts on taonga such as culturally significant species and resources, and the Māori values, practices, uses, and beliefs associated with these taonga.

YES

6b) If you answered yes, please provide information regarding impacts on Māori in the space below or as a separate attachment.

The NZIER independent economic impact assessment attached as Appendix B includes an assessment of impacts on Maori kiwifruit growers.

Māori kiwifruit growers own approximately 8.5% of the land established in kiwifruit in New Zealand and have exported just under 10% of industry volume of 13.9m trays for 2019 worth $133m in that year. Maori growers produced kiwifruit from 589 hectares of Gold orchards and 565 hectares of Hayward orchards.

In the past two years there have been numerous orchard acquisitions and new developments with Māori kiwifruit growers increasing their footprint in the industry. There is interest in the returns from kiwifruit compared to other land uses. There has been an increase of production of kiwifruit by Māori growers from 2016 to 2019. In particular, G3 (Sun Gold) production by Māori kiwifruit growers has seen a significant increase during that time. G3 provides greater returns and demands a higher consumer price compared to Hayward. There has been a slight reduction in Hayward production by Māori growers in the same time period. Māori Kiwifruit Growers Forum (MKGF) was set up in 2017 to represent the views of Māori kiwifruit growers and it has set the goal of Māori growers making up 20% of the industry by 2030 (MKGF Annual Report 2019). The majority of this investment is in regions that use HC.

HC is an important tool for Maori growers, just as it is for the wider industry. Impacts on Maori growers if HC was unavailable will be equivalent to other conventional growers in that region. The yield and other benefits will be the same as outlined in the NZIER report.

As part of preparing this response, a number of Maori growers were asked to comment. Please note these comments represent the views of individual growers rather than a collective Maori view.

- In areas with insufficient winter chill, continued access to HC is essential to profitable kiwifruit production. While some of the productivity losses could be made up through the use of alternative products, growers would suffer severe productivity declines and in some cases the viability of their orchard businesses would be marginal if they did not have access to HC.
- In areas with moderate winter chill, it is seen as important both as a backup for lack of winter chill but also for the benefits of standardisation of flowering. There are indications that in the medium term some Maori growers would proactively seek to move away from HC and utilise HC alternatives for Gold3 where they are proven to be viable. Currently Maori growers in these locations using HC would suffer significant loss of productivity if HC was not available.

- In the limited areas which have significant winter chilling, HC is seen as beneficial but not necessarily essential. The benefits of HC from standardisation of flowering are still substantial, however benefits from promotion of budbreak are less important.
- Without HC, there are large iwi businesses which employ locals and whanau, that would suffer significant hardship. If there were viable options to move away from the use of HC, some growers indicate a willingness and desire to stop using HC in the medium term, but acknowledge in some cases, productivity would decrease.

There are a diversity of views on HC within the Maori growing community, and it is likely submissions will be made during the public submission phase. The MKGF is well placed to represent the views of Māori growers and will be engaged in this process.

Part 7: Benefits and alternatives information

Suggested responders: importers, manufacturers, suppliers, applicators, users, growers (including industry groups), other affected parties

We are seeking information on the benefits associated with use of hydrogen cyanamide-containing substances, and what the possible effects of these substances becoming unavailable or significantly restricted would be.

7a) Do you have any information on the benefits of these hydrogen cyanamide-containing substances?

YES

7b) If you answered yes, please use the space below to detail these benefits.

A. NZ kiwifruit industry

The kiwifruit industry is a major contributor to regional New Zealand, returning $1.8 billion directly to rural communities in 2018/19. There are 2800 growers, 14,000ha of orchards, 10,000 permanent employees and up to 25,000 jobs during the peak season.

Figure 1: Direct Zespri payments 2018/19 by region

Source: Zespri

Around $76 million was returned directly to Northland, $57 million to Poverty Bay and $58 million to the upper South Island in 2018/19, the last reported period.

When the kiwifruit industry experienced a reduction in revenue due to the arrival of the vine-killing disease Psa-V in late 2010, many businesses and communities were negatively impacted. A significant portion of grower returns is recycled into local economies via wage expenses and other local purchases. So the impact of a revenue reduction or green orchards becoming uneconomic has an effect on communities. The independent economic impact analysis attached as Appendix B shows the potential for a significant revenue reduction if HC were removed. This necessarily has an impact on the communities that the kiwifruit industry supports through both loss of income and jobs.

B. Independent Economic Impact Analysis

NZIER prepared an independent economic impact analysis to provide an estimate and further understanding of the costs and benefits of removing HC from New Zealand kiwifruit orchards (Appendix B).

The report quantifies the benefits of HC in direct costs to growers, packhouses and Zespri and also considers additional losses from orchard management impacts alongside flow-on effects to associated businesses and development objectives and iwi development. Benefits are considered over one year and 10 years and provides three different scenarios.

NZIER identified the following benefits for the kiwifruit industry of the continued use of HC:

- Productivity (yield) gains associated with:
  - Promoting uniform and increased bud break
  - Increasing the number of flowers and preventing flower loss, in a compact timeframe (standardisation)
  - Increasing the number of king flowers which typically produce a larger and higher dry matter fruit than the lateral flowers. During flower thinning, the lateral flowers are removed, leaving the king flower for pollination. HC also reduces the number of unwanted lateral flowers.
- Ensuring early leaf growth which results in a longer growing season and bigger fruit.
- Removal of lichen and scale insects.
- Positive impacts on packhouses (crops are higher yield and more uniform in fruit quality which reduces fruit loss and food waste).
- Reduced labour costs on-orchard.
- Improved regional outcomes since kiwifruit is an important part of some regional growth strategies.
- Impacts on iwi businesses. Kiwifruit is seen as a growth opportunity for iwi in terms of revenue and labour employment.

These benefits are more fully explained in the NZIER report (Appendix B).

Not considered in the NZIER report but an important consideration is that HC allows for a more efficient carbon footprint as the per-hectare carbon impacts are spread over a larger output given that HC increases yield on orchards. This would have an environmental benefit as the kiwifruit industry strives to meet it publicly stated goal to be carbon positive by 2035.

7c) Do you have any information on the possible effects of these substances becoming unavailable?

YES

7d) If you answered yes, please use the space below to detail these possible effects.

The NZIER report found HC provides a key foundation for the successful development of the kiwifruit industry and potentially has multiple costs if removed:

- Significant on-orchard yield losses. Even in conservative scenarios, the use impacts of hydrogen cyanamide are significant. Without hydrogen cyanamide, the ability to “standardise” production on-orchard from bud-break to picking is greatly reduced. This leads to fewer flowers, fewer fruit and more variable maturity.

- The reduction in fruit picked and variable maturity will cause major disruption for packhouses and Zespri. Packhouses will suffer from reduced throughput, stranded assets, and poorer quality outcomes[1] while Zespri will find it difficult to grow existing markets and develop new markets.

The lack of hydrogen cyanamide will:

- Make labour less efficient on-orchard since the differing maturity levels of fruit in the same block will reduce standardisation of tasks– increasing the costs per tray as workers will need to revisit production blocks several times to do one task.

- Reduce employment since crop volume will be smaller.

- Have a detrimental impact on regional development and government regional development objectives.

The following analysis of the costs of HC removal is found in Appendix B with a fuller explanation of context and assumptions.

[1] There is a distinction between different maturity rates which lead to poor quality outcomes which likely to occur "without" hydrogen cyanamide use and the underlying quality of the fruit produced which is a durable competitive advantage for the industry.

NZIER Summary of costs and benefits

6% present value

	First year	Over 10 years	Comment
Direct Costs			
Growers	Between $233.8 and $300.5 million	Between $2,187 and $2,811 million	Significant losses. Increased impact the further north the orchard is.
Packhouses (illustrative only)	Between $23.2 and $29.8 million	Between $203.9 and $262.2 million	Significant losses and labour shedding.
Zespri	Severe short-term pressure on costs and opportunity cost of lost sales	Loss of markets or crop grown elsewhere	Increased cost per tray marketed.
Total direct costs	**Between $233.8 and $300.5 million**	**Between $2,187 and $2,811 million**	Numbers rounded
Other cost impacts			
Orchard management costs (illustrative only)			
Winter pruning	$17.3 million	$136.3 million	Costs increase by 30%.
Less overall labour	$5.8 million	$46.1 million	Costs increase by 20%.
Impact on other industries	**Between $93.5 and $120.2 million**	**Between $874.7 and $1,124.7 million**	**Suppliers to the kiwifruit industry.**
Government regional development objectives	Constrained	Likely to be a major constraining factor as time goes on	Likely to reduce the ability of government to reach its regional development objectives.
Impact on iwi development	Impact on new growth opportunities	Could constrain options as treaty settlements occur	Nearly 10% of the industry.

The NZIER report outlines a significant impact at a national level and it is also worth noting that at a micro level, for many Hayward (green) growers the removal of HC is a matter of business viability. This is because Hayward is a lower-yielding and lower-returning variety. Opportunities for growers to convert green orchards to more profitable varieties are restricted, as Gold3 and Red licence is limited and capital investment is significant. This likely risks some green orchards converting to another industry which is a less efficient use of land. Kiwifruit is a high-returning land use, returning $1.8 billion directly to growers in rural economies in 2018/19.

A further comment relates to the environmental impact of removing HC. Many costs are fixed per hectare. Because the removal of HC reduces the number of fruit per hectare, the environmental 'footprint' per piece of fruit will increase.

The NZIER report necessarily focuses on yield impacts as these are quantifiable in a number of scenarios. Using HC provides other benefits for growers in all regions. Condensing flower timing has significant benefits for growers but these are harder to quantify.

7e) Do you have any information on the availability, relative cost, effectiveness, and safety of any alternative substances that could be used if these hydrogen cyanamide-containing substances became unavailable?

YES

7f) If you answered yes, please use the space below to provide this detail.

The identification and assessment of alternatives to HC has been a priority for Zespri for the past 10 years with all potential products identified then investigated. Following the 2006 reassessment of HC and more recently with Zespri's focus on sustainability, the pursuit of alternative products has increased in importance, however, this is countered by a shortage of emerging products to trial.

Investment to date by Zespri has amounted to around $900,000 with a further $450,000 approved in 2020, and additional investment on top of this by product manufacturers and Plant & Food Research. The extent of the research investment has been limited by lack of potential products to test rather than the funds to test them. One of the challenges is, that on a global scale, kiwifruit is a relatively minor crop making up just 1.5 percent of globally-traded fruit, therefore developing budbreak enhancers for our industry is not a priority of global chemical companies and candidates tend to come from smaller companies or research institutes.

In addition, Zespri's $20 million annual investment in its joint new varieties breeding programme with Plant & Food Research actively seeks to identify varieties that will be productive in areas which lack winter chilling. Investment has also been made into physiological treatments for improving budbreak for example, wood type selection, late tipping and trunk girdling. This work is harder to evaluate costs for, as those trials have multiple goals.

C. Impact of alternatives

The report from NZIER (Appendix B) considers alternatives to HC for the kiwifruit industry and provides an assessment of the impacts if alternatives are 10% and 30% as effective as HC. A further scenario is provided where alternatives are 50% as effective as HC but this is extremely optimistic, as trial work and practical use by growers suggests this scenario is unlikely.

D. Uptake of alternatives

While some of the commercially-available alternative products have been available for some time, there has been limited uptake by growers because effectiveness is highly variable and impact of failure on profitability is high. Growers cannot afford to take the risk of using alternatives unless they are proven to provide consistent results.

The alternative products all have very sensitive application windows and need to be applied at exactly the right time to work. If weather conditions delay application or if spray contractors are not available, the optimal timing can be missed. With HC there is a wider window of application and it is therefore easier to get the timing right.

E. Summary of alternatives research

Zespri has evaluated 18 alternative budbreak products. This includes products commercially available in New Zealand and in the Zespri Crop Protection Standard, products commercially available in other countries and a number of coded formulations, which are not commercially available. Five products are listed in the Zespri Crop Protection Standard as alternative budbreak enhancers.

More detailed information on the outcomes of alternatives research is available on request.

Key findings:
Commercially-available alternative products were less effective compared with HC both within the same trials and when looking at data combined from multiple trials. In these trials, the average efficacy (increase in king flowers per winter bud) versus HC ranged 51-93% in Gold3 and 24-133% in Hayward, dependant on region. The impact was greater in Hayward, and in in warmer regions that experience less winter chill.

- Armobreak efficacy ranged 26-46% in Gold3 and 27% in Hayward. Regional differences in efficacy were less noticeable than for HC. Trial results in Hayward were extremely variable.
- In Gold3 trials, Advance Gold resulted in approximately half the efficacy of HC, ranging 25-49%. Generally Advance Gold is believed to work best in the cooler regions, however, that is not what is seen in the trial results.
- Erger has had minimal testing through these trials, however results indicate that this product can give similar increases as HC in king flower production in Gold3 and trial results indicate this product may be better suited to warmer regions like Kerikeri (limited data). Low level efficacy has been observed in Hayward.
- In these trials, Waiken demonstrated very poor results (single trial per variety with 5 application timings).
- BluPrins demonstrated potential to give good increases in king flower production, however when viewing results of multiple trials, the product resulted in only approximately 40% of the efficacy of HC in Gold3 and less in Hayward.

Getting application timing right is important for all products. The results from trials where multiple timings were tested indicates there is a narrow window of application for these alternative products, far more so than is the case with HC.

Trial work is generally based on small plot trials which evaluate percentage budbreak achieved and number of king flowers per winter bud produced. Promising alternatives need to be further evaluated at full orchard level with assessment of yield and other benefits to determine if they are practically viable. This work is undertaken by the manufacturer and by growers. It will take several years of trial work to establish if an alternative compound provides consistently good outcomes and this work must be completed before it could be considered a viable alternative.

Part 8: Any other pertinent information

Suggested responders: importers, manufacturers, suppliers, applicators, users, growers (including industry groups), other affected parties

8a) Do you have any other pertinent information, not covered by the questions above, related to hydrogen cyanamide or the hydrogen cyanamide-containing substances?

YES

8b) If you answered yes, please use the space below to detail these. Feel free to include any further pertinent information as additional attachments.

A. Incident Data

Summary of reported incidents

This section summarises two data sets relating to HC use on kiwifruit and examines trends.

1. The National Poisons Centre
2. NZKGI spray complaints

National Poison Centre Data 2002 - 2019

NZKGI requested a report[2] from the National Poisons Centre (NPC) to provide feedback to the EPA on incidents and injuries caused by HC use in New Zealand.

Analysis of the NPC data from 2002 through to 2019 indicates in total there were 174 calls received to the National Poisons Centre over the past 17 years. The data was reviewed, and it was noted that 20 reports are unlikely to relate to the use of HC in kiwifruit or are not related to an exposure case.

- 100 calls related to 103 human exposures.
- 41 were information-only calls – i.e. no exposure had occurred.
- 33 calls were about animals being exposed (28 dogs, 1 cat, 1 horse, 1 sheep and 1 rabbit). There is insufficient data to comment more specifically on animal exposure.

The data for the 103 human exposures has been analysed to investigate the causes of the incidents reported and includes a description of the circumstances surrounding each incident. Much of the NPC data is ambiguous and it is hard to draw concrete conclusions that directly relate to the application of HC in kiwifruit orchards.

- 40% of all exposures were reported before 2006 when the amended controls on HC were implemented (i.e. 41 enquiries of the 103 total).
- Reported incidents of human exposure dropped from 10.25 per year before 2006 to 4.43 per year on average from 2006 - 2019.
- 51% (53 of 103 calls) were referred for medical referral and or assess / observation. Of these 53, 19 required active investigation / treatment.
- 47% (48 of 103 calls) required self-treatment or no treatment at all or were unrelated medical incidents or non-medical referrals.
- 50% (51 of the 103) occurred in the workplace and 6 cases were directly related to insufficient PPE.
- 10% (11 of the 103) incidents related to public spaces and environmental exposure.
- The majority of calls (87%) were received in the July - September period (application of HC to kiwifruit is recommended between late July and early September).

[2] *available upon request*

NPC route of exposure summary

Route of exposure	#
Inhalation	45
Skin	34
Ingestion	12
Inhalation, skin	5
Eyes, ingestion, skin	3
Unknown	4
Total	103

This data shows that if the correct PPE is worn and people do not enter properties where HC being is applied (i.e. obey signage) – the exposure incidents would dramatically decrease.

The raw call data was also analysed to assess the main causes of incidents. This is summarised as follows: Of the 100 HC calls (concerning 103 incidents) made to the NPC:

- 18 incidents relate to reported spray drift
- 13 calls mention use of HC in kiwifruit directly
- 11 calls relate to user drinking alcohol following exposure – i.e. not observing the label warning
- 10 calls relate to users wearing either no PPE or PPE that malfunctioned or was broken
- 2 calls mention vineyard (ie grapes) and citrus – where HC is not known to be used in NZ and one an apple orchard (which HC is registered on).
- 1 relates to kiwifruit being consumed following spraying
- 1 relates to a re-entry the property before sign says it is safe to do so.

Industry spray feedback log

All spray complaints received by NZKGI have been reviewed since 2014. Over this period, 82 calls were received of which 48 (59%) related to HC. Some calls were received seeking information only (i.e. not a complaint) on HC. Complaints that have not been attributed to a specific product have been counted as HC in these figures when received over the HC application period.

The below summarises key data for the 48 calls:

- 2 were general enquiries seeking information / a general complaint with no harm observed
- 2 related to a lack of notification and spray drift
- 27 complaints related to inadequate or no notification (no adverse events occurred).
- 5 complaints related to signage for orchard re-entry (being insufficient or caller seeking clarification).
- 10 related to drift observed without any adverse effects.
- 2 complaints were for direct exposure, of these both resulted in mild symptoms.

All complaints received are investigated by Zespri to determine their validity and to ensure appropriate corrective actions are taken. Failure to comply with Zespri's standards can result in several actions being taken. These actions are dependent on the seriousness of the incident, ranging from warning letters, increased monitoring, financial penalties though to non-acceptance for supply and destruction of produce. All incidents are logged and details held on the grower's file for follow up at their next GAP audit.

Appendix A – New Zealand Environmental and Human Health Risk Assessment Report to Support Reassessment, Australian Environment Agency Pty Ltd

Please see separate pdf document.

Appendix B – Independent Economic Impact Analysis, NZIER

Please see separate pdf document.