



ERNSLAW ONE LIMITED

Environmental and Social Risk Assessment (ESRA) for Glyphosate

**Prepared by the NZ FSC Economic Chamber Cluster Group in support of
the use of Glyphosate in Plantation Forests**

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The Case for an Environmental and Social Risk Assessment

The Forest Stewardship Council (FSC) recently reviewed its list of Highly Hazardous Pesticides (HHP) and has designated Glyphosate as a “restricted pesticide” due to rising concern regarding chronic toxicity and as a probable carcinogen. Until the most current FSC review, Glyphosate had not been considered as an HHP.

FSC have developed an Environmental and Social Risk Assessment (ESRA¹) process, so that certified forest owners can better understand and manage glyphosate’s environmental and social risks as a part of their approach to integrated pest management.

FSC Pesticides Policy (FSC-POL-30-001 V3-0 EN, page 8), effective August 2019, available on our intranet, specifies:

‘If an Organization identifies the need to use an FSC prohibited HHPs (in an emergency situation or by governmental order), an FSC highly restricted HHP, an FSC restricted HHP or other chemical pesticide and does not have a valid (pre-existing) derogation for its use, they shall:

- conduct an environmental and social risk assessment (ESRA) in accordance with this Policy.
- incorporate to their ESRA the conditions from the more recent derogation approved in the country for that chemical pesticide, if there is one.
- incorporate to the ESRA, the requirements from the most recent published draft of the IGI.’

For clarity, Ernslaw would not delay an emergency response or defy a government order to use a designated HHP but would commit to undertake an ESRA retrospectively.

A Joint Australian and New Zealand ESRA for Glyphosate

The FSC Pesticide Policy allows for the collaboration of organisations with similar weed and pest problems and forest conditions to take a joint approach to develop an ESRA (section 4.13 (1)).

Australian and NZ forestry companies holding FSC have used a collaborative approach to develop a glyphosate ESRA, because:

- Glyphosate is used widely for similar purposes in plantation forests in both Australian and NZ
- Some companies have forests they manage on both sides of the Tasman, so consistency between international operations is important
- Both countries have advanced regulatory control regimes governing the use of hazardous substances including pesticides
- A single ESRA will improve consistency between companies and the FSC audit bodies approach to the management of glyphosate

¹ <https://nz.fsc.org/en-nz/policies/forest-management-02/pesticide-use> (July 2019) and <https://nz.fsc.org/preview.pesticides-policy-implementation.a-1539.pdf>

Background on Glyphosate Use in Australia and NZ

Australia and NZ have many aggressive and competing plant pest species which require control for effective plantation management. Plantations are relatively vulnerable to these pest plants. Many were introduced and have adapted well and aggressively spread as they out-compete the indigenous species.

Australia and New Zealand apply glyphosate in the following operations:

- Pre-plant and post-plant (with shield) spot spray
- Pre-plant desiccation (aerial)
- Weed control around infrastructures like buildings, roadsides, fire ponds and other sites
- Wilding conifer or pest tree control (“drill and fill” or cut-stump pasting)
- General noxious weed control (by knapsack back-pack or hand held spray wand – wide dispersive)
- Nursery weed control

In New Zealand, glyphosate is one of the pesticides regarded as essential for use in forestry. It is used as a pre-plant desiccant, almost always in combination with metsulfuron-methyl (Meturon™), to manage a broad range of weeds before tree planting. The synergistic effects with metsulfuron mean that where glyphosate would create a partial control at a much higher application rate, the addition of metsulfuron produces better control with less total chemical (for clarity: FSC does not designate metsulfuron as a HHP). Because Glyphosate is a non-specific herbicide, with no residual knockdown effect, there is minimal use post-planting. Therefore, glyphosate is typically applied once in a rotation which is approximately 25 - 30 years for radiata but considerably longer for Douglas-fir and redwoods.

In New Zealand glyphosate is almost always aerially applied in late summer and early autumn for weed control prior to replanting and in other seasons for road side spraying. Application rates are ~3.5 kg a.i. per ha carried in 150 litres of water.

Planting into non-desiccated (non-sprayed) cutover (where weeds are not controlled) generally leads to poor tree survival and growth but prolific weed growth. Often multiple applications of other herbicides, or repeated manual treatments, are needed to control the weeds.

The advantages of pre-plant spraying are:

- Provides the best opportunity to control current problem weeds which otherwise cannot be effectively managed once seedlings are planted
- Improves planting work conditions and productivity and those of future silvicultural operations
- May reduce the need for burning or mechanical land preparation operations
- Promotes early tree growth and provides short term weed control until the spring flush of germinating weeds
- Helps limit the spread of undesirable weeds further into the estate.

Glyphosate is also used in other forestry weed control activities including:-

- Control of invasive weeds within plantation and surrounding infrastructure
- Maintenance of road verges (ditch lines), firebreaks and fire dams
- Control of edge- spread of wildling conifers that are threatening to invade surrounding native vegetation

Glyphosate is widely used in NZ in both pastoral and arable agriculture, with MPI testing² showing it above detection levels in cereal crops (20 of 60 samples in wheat in 2016) which means there is a potential, albeit very low-level, baseline exposure for anyone who eats bread, frozen peas or consumes malt based drinks (beer).

Scope of the Glyphosate ESRA

The FSC's Pesticides Policy (201) outlines what needs to be included in an ESRA. This document covers the policy requirements of 4.12: 1, 2, 3, and 5, 7 (part), 12 and 13.

4.12 The Organization shall:

1. Give preference to:
 1. non-chemical methods over chemical pesticides,
 2. chemical pesticides not listed in the FSC lists of Highly Hazardous Pesticides (HHPs) ahead those listed in the FSC lists of HHPs,
 3. FSC restricted HHPs over FSC highly restricted HHPs.
2. Undertake a comparative ESRA according to scale, intensity and risk (SIR) as part of its integrated pest management to identify the lowest risk option to control a pest, weed or disease, the conditions for its use and the generic mitigation and monitoring measures to minimize the risks.
3. Consider in their ESRA the minimum list of types of hazards, exposure elements and exposure variables described in Annex 2.
4. Select the option that demonstrates least social and environmental damages, more effectiveness and equal or greater social and environmental benefits.
5. Conform with the applicable international and national indicators and thresholds for the use of HHPs.
6. Before applying any chemical pesticide, incorporate the results of their ESRA to site operational plans, to identify site-specific risks and adapt the generic mitigation and monitoring measures previously identified in the ESRA (Clause 4.12.2).
7. Make the ESRA and incorporation to the operational plans available to affected stakeholders³ upon request.
8. Consult the online FSC database for information exchange on alternatives and monitoring procedures.
9. Have programmes in place, proportionate to SIR, to research, identify and test alternatives to replace FSC highly restricted HHPs and restricted HHPs with less hazardous alternatives. Programmes shall have clear actions, timelines, targets and resources allocated.
10. Engage with stakeholders in conformance with the requirements in the applicable National Forest Stewardship Standard or Interim National Standard when conducting ESRA.

² <https://www.mpi.govt.nz/food-safety/food-safety-for-consumers/whats-in-our-food-2/chemicals-and-food/agricultural-compounds-and-residues/glyphosate/>

³FSC defines affected stakeholder as local communities, Indigenous Peoples, workers, forest dwellers, neighbours, downstream landowners, local processors, local businesses, tenure and use rights holders, including landowners, organizations authorized or known to act on behalf of affected stakeholders, for example social and environmental NGOs, labour unions, etc. (Source: FSC-STD-01-001 V5-2 *Principles and Criteria for Forest Stewardship*)

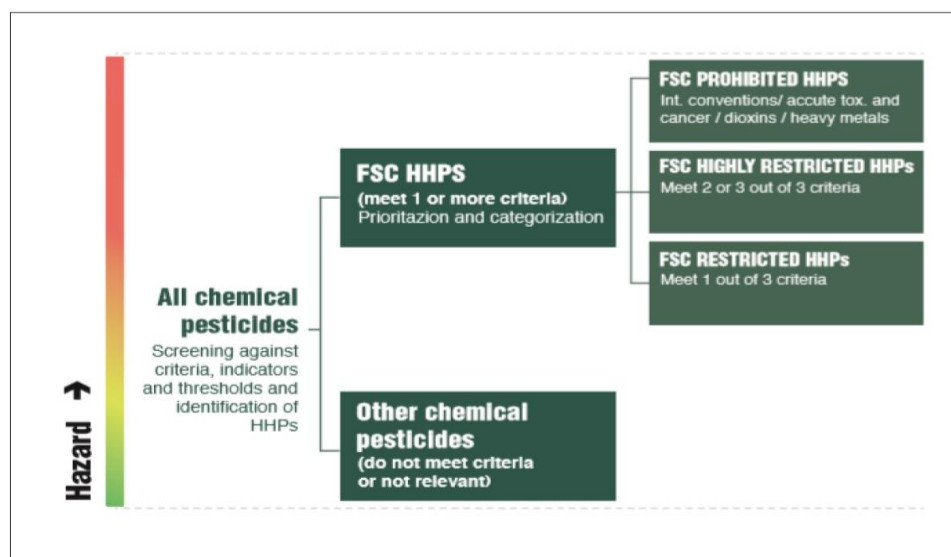
11. Not use any FSC Prohibited HHPs except in the case of an emergency situation or by governmental order. (See Annex 3. Procedure for use of FSC prohibited HHPs in case of emergency situations or governmental orders).
12. Inform third-party processing plants located in the spatial area of the MU and third-party nursery suppliers of the list of FSC prohibited chemical pesticides, encouraging them to avoid these pesticides in their processes and in the production of seedlings and other materials entering the management unit.
13. Request the list of FSC prohibited chemical pesticides used by processing plants and nurseries suppliers described in clause 4.12.12.

Methodology

The methodology followed is consistent with FSC's rules and guidance documents. The key FSC documents are the Pesticides Policy, the Principles and Criteria, and the Integrated Pest Management Guidance document. The former provided the report format. Criterion 10.7 provides overarching focus:

'The Organization shall use integrated pest management and silviculture systems which avoid, or aim at eliminating, the use of chemical pesticides. The Organization shall not use any chemical pesticides prohibited by FSC policy. When pesticides are used, The Organization shall prevent, mitigate, and/or repair damage to environmental values and human health.'

FSC has produced an addendum to the Pesticides Policy; the FSC Lists of highly hazardous pesticides, FSC-POL-30-001a EN (1st May 2019). FSC takes into account the toxic characteristics for humans and the environment of chemical pesticides and identifies highly hazardous pesticides using internationally recognised hazard groups and criteria, and the associated indicators and thresholds listed in Annex 1 of the FSC Pesticides Policy. Glyphosate has been classified as a restricted pesticide (as opposed to Highly restricted, or Prohibited as per the diagram below) due to its chronic toxicity and as a probable carcinogen.



The rationale for glyphosate to be on FSC's HHP list as a restricted chemical can be seen in the following table⁴.

⁴ <https://fsc.org/en/document-centre/documents/retrieve/a99ba21e-8886-4946-8cb7-7f5e04226d0f> (May 2019)

It is a fundamental of the ESRA to understand glyphosate's toxicity status in much more detail because there is no additional supporting information provided by FSC on the specifics of the classification other than what is within the table as shown below.

FSC RESTRICTED LIST 221 pesticides			INTERNATIONAL CONVENTIONS			ACUTE TOXICITY			CHRONIC TOXICITY								ENVIRONMENTAL TOXICITY		DIOXIN & HEAVY METALS	
ID	CAS number	Pesticide active ingredient	1.1.a Stockholm (POP)	1.1.b Rotterdam (PIC)	1.1.c Montreal	2.1.a Extremely or highly hazardous (Ia and Ib)(WHO)	2.1.b Acute toxicity mammals and birds LD50< 200mg/kg body weight	2.1.c Fatal if inhaled (H330) (GHS)	3.1.a Carcinogen and probable carc. (1 and 2A) (IARC)	3.1.b Carcinogen and probable carc (US EPA)	3.1.c Carcinogen and probable carc. (1A &1B) (EU GHS)	4.1.a Mutagen and probable mut. (1A and 1B) (EU GHS)	5.1.a Reproductive toxicant and probable repr. tox. (1A and 1B) (EU GHS)	6.1.a Category 1 (EDC EU)	6.1.b Suspected carcinogen (Cat. 2)(GHS) and Endocrine Disruptor (Cat. 2) (GHS)	7 Aquatic Toxicity (LC/EC 50 <50 µg/l)	8 Environmental toxicity (Persistent; Bioaccumulation; Leaching)	9 Dioxin	10 Heavy Metal	
90	51630-58-1	Fenvalerate														•				
91	120068-37-3	Fipronil					•													
92	69806-50-4	Fluazifop-butyl											•							
93	79622-59-6	Fluazinam														•				
94	174514-07-9	Fluazolate														•				
95	33245-39-5	Fluchloralin														•				
96	101463-69-8	Flufenoxuron														•				
97	62924-70-3	Flumetralin														•				
98	103361-09-7	Flumioxazin											•							
99	136426-54-5	Fluquinconazole					•													
100	85509-19-9	Flusilazole											•							
101	106917-52-6	Flusulfamide					•													
102	133-07-3	Folpet								•										
103	68157-60-8	Forchlorfenuron															•			
104	50-00-0	Formaldehyde								•	•									
105	98886-44-3	Fosthiazate					•													
106	121776-33-8	Furilazole								•										
107	77182-82-2	Glufosinate-ammonium											•							
108	Group	Glyphosate and its salts							•											
109	108173-90-6	Guazatine						•												

Note that there is not a consistent view between the three assessments on carcinogenicity. This document describes the current state of knowledge and categorises the different hazards and exposure elements so that we can better manage glyphosate.

Weight of evidence combined with the Precautionary Principle

A precautionary approach is used in developing the glyphosate ESRA as is consistent with FSC Principle 9. FSC used this approach in developing its List of Highly Hazardous Pesticides because the carcinogen trigger only requires one of the three sources of evidence to identify a possible causal effect.

One of the key components of the FSC's ESRA is completing the table 'Identification and assessment of risk – function of toxicity and exposure- and mitigation strategies to minimize it', as outlined on page 41 of the pesticides policy.

The precautionary approach is used because:

- A very recent paper published in Mutation Research/Reviews indicates that people with high exposures to the Glyphosate have a 41% increased risk of developing a type of cancer called non-Hodgkin lymphoma⁵
- There is only limited research on the risks associated with the use of glyphosate use in plantation forestry. The following are extracts from Rolando et al, June 2017⁶ publication, *The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests*
- 'Relatively few scientific syntheses or risk assessments on glyphosate specific to its use for the management of vegetation in planted forests are available. Moreover, those that have been conducted tend to be regionally specific or not readily available in the public domain [5–8, 27]. Fundamental to toxicological and ecotoxicological evaluations is a quantitative understanding of the probability, duration, magnitude and potential routes of exposure that are largely controlled by sector-specific use patterns, such as for those practiced in planted forests.'
- Most of the studies cited in this review were heavily focused on glyphosate products used in North American forests, with minimal or no information on the environmental fate, and effects of glyphosate-based products, in planted forests of other regions of the world with differing tree species, silvicultural regimes, and environmental conditions (i.e., climate, soil etc.). While this could represent a gap in the data available to reliably assess the risk to the planted forest environment of glyphosate based herbicides, there are few reasons to expect significantly different outcomes, barring identification of more sensitive species than those studied to date, drastically different environmental characteristics or new formulations or mixes that incorporate components with higher inherent toxicity.'
- Some NGO's and some Government bodies refute or are skeptical of academic and government assessments of the toxicity around pesticides like glyphosate. Their assessments of the effects of glyphosate support FSC's approach of looking for non-chemical alternatives or ones that are less hazardous. Also, there are increasing concerns from some social and environmental organisations around aspects that existing reviews find challenging to assess like the broader issues of pesticides and how they modify the environment and reduce the resilience of the landscape.

The FSC's ESRA table and accompanying mitigation within the body of the report needs explicit information that will direct forestry companies on how to manage potential risks. Reports are not always consistent in their assessment. For example, they may use different data, weigh the significance of

⁵ <https://www.sciencedirect.com/science/article/pii/S1383574218300887>

⁶ www.researchgate.net/publication/317556521_The_Risks_Associated_with_Glyphosate-Based_Herbicide_Use_in_Planted_Forests

evidence differently, or were written after other reports so could include new information or review potential shortcomings of earlier assessments. It is not helpful if a table column is completed with a 'Yes' and a 'No', or a 'Low' risk and a 'High' risk. Therefore, in combination with the precautionary principle will be a weight of evidence approach.

Weight of evidence tries to assist this process. Detailed evidence in the appendices is intended to help formulate policy and procedures in the Ernslaw Silvicultural manual regarding the level of risk and the proposed mitigation to eliminate, reduce or manage it, and to ensure compliance with our obligation as a PCBU to ensure appropriate workplace exposure and health monitoring under the Health and Safety at Work Act's General Risk and Workplace Management regulations (2016).

The three assessments listed in the restricted table, along with other assessments, including the Australian and NZ government's glyphosate monographs, provide information useful in understanding and categorising the different hazards and exposure elements. Collectively they draw off many hundreds of studies into aspects of glyphosate that would likely cover tens of thousands of pages.

This report will only list the various sources and extract quotes around the different potential hazards. It is not a re-evaluation.

The reports used are the:

1. Australian Pesticides and Veterinary Medicines Authority, September 2016. Regulatory position: consideration of the evidence for a formal reconsideration of glyphosate ISBN 978-1-925390-49-0 www.apvma.gov.au
2. European Union European Chemical Agency (ECHA) Press Release Helsinki, 15 March 2017 <https://echa.europa.eu/-/glyphosate-not-classified-as-a-carcinogen-by-echa>
3. Current status of glyphosate in EU, https://ec.europa.eu/food/plant/pesticides/glyphosate_en
4. New Zealand Environmental Protection Agency, August 2016 Review of the Evidence Relating to Glyphosate and Carcinogenicity <https://www.epa.govt.nz/assets/Uploads/Documents/Everyday-Environment/Publications/f2f72882a7/EPA-glyphosate-review.pdf>
5. Pesticide Action Network International (PAN) glyphosate monograph, October 2016 <http://pan-international.org/wp-content/uploads/Glyphosate-monograph.pdf>
6. US EPA The Revised Glyphosate Issue Paper of December 12, 2017 <https://www.epa.gov/ingredients-used-pesticide-products/draft-human-health-and-ecological-risk-assessments-glyphosate>
7. US EPA Letter to registrants about glyphosate
8. https://www.epa.gov/sites/production/files/2019-08/documents/glyphosate_registrant_letter_-_8-7-19_-_signed.pdf
9. World Health Organisation's International Agency for Research on Cancer (IARC) Monograph on glyphosate, featured news, <https://www.iarc.fr/featured-news/media-centre-iarc-news-glyphosate/>

Overview of Available Alternative Methods to Applying Glyphosate

1. Give preference, as a matter of principle, to:
 1. non-chemical methods over chemical pesticides,
 2. chemical pesticides not listed in the FSC lists of HHPs over those listed in the FSC lists of HHPs,
 3. FSC restricted HHPs over FSC highly restricted HHPs.

Overview

The purpose of this section is to demonstrate that there is a need to use glyphosate over non-chemical methods or chemicals that FSC considers are less hazardous.

There are many alternatives to the application of pesticides. The challenge isn't about finding alternatives because there are many, it's about finding alternatives that prove as practical, safe or cost-effective as glyphosate. This section describes each of the alternatives.

FSC certified organisations in both Australia and New Zealand have been supporting pesticide research into alternative methods as part of their commitment to FSC for nearly 20 years. In conjunction with this, the Australian and NZ FSC certified organisations have been following the 'remove, replace or reduce' (3 R's) philosophy at the heart of the FSC's pesticide policy's 4.12 (1) since it was introduced.

Alternative methods are part of the Integrated Pest Management (IPM) 'toolbox'. Ernslaw and other FSC certified companies have been steered by the FSC Guide to integrated pest, disease and weed management in FSC certified forests and plantations⁷ since certification. Options range from:

- Ignoring or avoiding the problem
- Take no action (but neither is not consistent with good forest management)

Through to:

- Using biological control options (including funding research thereon)
- Improving crop species selection to reduce the impact of the weeds
- Changing silviculture management
- Using environmental manipulation, e.g. mechanical methods
- Using selective pesticides
- Using broad-spectrum pesticides
- Applying a selective area spray application
- Changing spray timing to reduce application rates

The Pesticide Action Network International glyphosate monograph (PAN 2016), suggested alternatives to the use of glyphosate. Most of their non-farming specific suggestions have already been trialled in Australian and NZ forests. These are discussed in this section. PAN listed:

- Hand removal including grubbing, pulling, cutting, hoeing
- Use of mechanical methods such as mowers, slashers and trimmers

⁷ <https://fsc.org/en/document-centre/documents/resource/383>

- Use of browsing animals to control weeds in some situations
- Smothering methods e.g. with weed mat, carpet or cardboard covered with mulch
- Introduction of selected biological control organisms that target certain invasive, exotic weeds.

A major challenge is attracting people to work in the primary sector, including forestry. Changing demographics over a century in both Australia and NZ now mean we are urban societies, with over 90% of people living in an urban setting. This has made it increasingly difficult to get people to do manual forest operational tasks like weed control. Compounding is unemployment is at historically low levels, so there are fewer incentives for people to travel and do harder physical work like forestry. For example, NZ is now reliant on overseas workers for much of the primary sector including some in silviculture (planting, including weed control, pruning and thinning). Unfortunately, this comes with its own set of social or cultural challenges and is often politicised.

Burning

Burning is a pre-plant control option but requires a heavy enough fuel load so that the fire can cover the control area. It is an option where there is heavy woody debris or slash following harvest or in afforestation blocks that have required existing weeds/vegetation to be roller crushed. Fire can create significant risks within and outside of the control area.

Burning is not widely used but can have a useful role in weed management, including wilding conifer control. The following need to be considered:

- Large scale burning can impact nesting birds, or skinks and geckos or giant land snails when present
- Weather conditions mean it is challenging to have an effective and safe burn
- Fire often promotes weed seed-germination and growth, particularly of legumes including Acacias
- Weed re-infestation of burnt sites is generally rapid and widespread. Therefore, post-planting spot spray or aerial application is also often required on burned cutover
- A pre-burn herbicide application may be necessary to kill the vegetation so that it is dry enough for a successful burn
- Large scale burning can have other adverse environmental effects such as a reduction in air quality, (increasing fine particulates), increased soil erosion and sediment discharge, loss of water retention in topsoil, and volatilisation of nutrients from the site leading to long-term productivity loss
- Delays to burning can be costly because of the requirement to retain fire fighters on site and helicopters on call.

Mechanical Land Preparation

Mechanical land preparation can be used to prepare the land for planting if woody debris is heavy on the harvesting site or afforestation area. Debris is pushed into heaps or windrows to make the site suitable and safe for planting. Mechanical land preparation can be widely used in flat or rolling terrain where machines can readily access the site.

Mechanical land preparation is a useful tool but often has a minor role in weed management. The reasons are:

- Limited to sites with stable and not easily erodible or compactable soil. Large machines can cause soil compaction, which affects root development and tree growth. This can be significant, particularly in

the first two years of growth where rapid development is essential to minimise the amount and duration of weed control.

- Cultivation can stimulate weed growth. This often leads to the need for a pre-plant and post-plant herbicide application. However, the overall combination of cultivation and an appropriate herbicide application may reduce the amount of pesticide applied depending on site conditions
- In New Zealand, large areas of plantations are in steep hill country which is not suitable for widescale mechanical land preparation.

Hand Weeding

Hand weeding includes cutting, hoeing and hand pulling sites to prepare for planting or for post-plant releasing.

Hand weeding is an IPM option but is considered to have a minor role in weed control for the following reasons:

- Recruiting and retaining trained and skilled workers is challenging. At the time of year where weed control is needed, horticulture and viticulture also demand labour which tends to be closer to town than forests and more appealing to manual workers. NZ's current historically low unemployment rate doesn't make manual and monotonous tasks attractive.
- Hand weeding usually does not kill the target weed, and control may be too short-lived. Weeds that aren't killed can re-sprout faster and with multiple regrowth from any cut stem.
- The size of the work programme, and the window of time to complete it, often means it would be almost impossible to get the job done within the optimal control period prior to replanting a site.
- Hand weeding is time-consuming, and is at least ten times more expensive than chemical application.
- Hand weeding on steep terrain can be unsafe as it involves the use of slashers and grubbers.

Mechanical Releasing

Use of hand-held motorised rotary head 'scrub bars' is very hard work and often results in high mortality of seedlings, and they pose a risk to operator safety. Tractor mounted mowers, brush-cutters and chopper-rollers can be used for mechanical weed control but only on flat ground or low angle slopes. Mechanical releasing in NZ and Australia has limited utility. It is estimated that only 3% of annual vegetation management is undertaken mechanically.

Mechanical releasing is restricted because:

- Machines are limited to flat to rolling sites with stable and not easily erodible or compactable soil. Large machines can cause soil compaction, which affects root development and tree growth.
- Mechanical methods usually do not kill the target weed, but only slows growth temporarily and in some species can increase the weed.
- Mechanical inter-row cutting can damage the stems of the crop trees when machines get too close. However, leaving a wide margin uncontrolled then leaves a strip of competing weed close to the tree which may require additional treatment (hand scrub cutting or pesticide treatment) to give adequate control. Also, the machine cannot move between rows due to tree spacing at typical stocking rates of 1000 stems per hectare, especially where there is side slope.
- Where frosting is a problem, mechanical treatment is unable to obtain the weed control necessary to allow air movement that reduces frosting.

Oversowing With A Grass Crop

Oversowing aims to rapidly establish a grass cover crop to outcompete the original weed species, mainly woody weeds. Oversowing is another option in the IPM 'toolbox'.

Oversowing can work well in some situations but typically does not eliminate the need for chemical pesticide and may in fact increase the volume used.

There are challenges to reliance on oversowing:

- Oversowing is inherently unreliable. In some cases, it works well, but this is not predictable
- Oversowing is unsuitable where soil moisture levels are low as the grass competes with the crop for moisture, or in areas that are frost prone because the grass reduces air movement
- For effective oversowing, a pre-sowing herbicide application is required to achieve effective strike
- Spot spraying is still likely to be required to reduce the competition from the grass or legume cover around the seedlings
- In some situations, oversowing can promote caterpillar infestation that may require intervention with an insecticide.

Grazing

Grazing with cattle, sheep, (or goats and pigs) in young plantations may occur in some situations. For example, it can be beneficial in pampas infested areas. It is more suited to forests with a low stocking density than usual commercial stocking rates.

Grazing is an IPM option but is considered as an alternative in specific situations. This is because:

- Grazing is not usually possible before the age of three because of the risk of trampling and browsing to the trees. As the most critical time for weed control is before planting and up to two years old, it is not suitable
- The initial set up costs are high because there must be water available and the area fenced so they don't impact on waterways, wetlands and riparians, or high conservation areas
- Grazing can stimulate the grass crop and does not remove the vegetation competing for moisture, light and space
- Stock rustling can be a problem in some locations which leads to damaged forest access gates and opportunities for rustlers to be involved in other illegal activities like growing drugs.

Weed Mats

Weed mats are made from materials such as paper, hessian, recycled wool carpet or black plastic.

Weed mats have a place in the IPM toolbox but have challenges for widespread deployment:

- Weed mats reduce the amount of soil water because water is deflected away from the tree by the paper or plastic
- They required high maintenance (often wind affected)
- They are slow to install, and the materials are bulky to carry. Stakes or pegs are often needed to stop the mats from being blown away. We are trying to minimise the amount of plastic in the environment

- Getting labour and installing them promptly post-plant would be challenging. However, they may be suitable for highly sensitive sites (eg wetland restoration)

Biological Control

The biological control of weeds using insects or fungi has been researched, developed, and implemented for many years. In NZ, biological controls on gorse, broom, buddleia, thistle, old man's beard, and blackberry have been released, and further releases are ongoing. For example, gorse is susceptible to damage by the gorse weevil, but the weevil needs to thrive to make any noticeable difference. Other biological control trials have included gorse spider mite, gorse thrips, the bronze beetle and raspberry bud moth for blackberry, and the buddleia leaf weevil to name a few. Like many other methods of pesticide and alternative controls, they form part of the pest control 'toolkit'. In Australia many attempts at biological weed control have been attempted. The only one which has demonstrated partial effectiveness is blackberry rust, however in practical terms this makes little difference to the blackberry infestations.

Mycoherbicides are a form of biological control. They are naturally occurring fungal pathogens that have been developed to control weeds. Usually, they are host specific, making them selective to the target weed species. Extreme care is required in the trialling of mycoherbicides to ensure that the crop tree and other desirable species are resistant. They may offer some benefits in forest weed control. *Fusarium tumidum* is a fungus which attacks gorse and has proved successful in glasshouse trials. There is a risk of mammalian toxicity associated with some strains of fungus which are being evaluated. Mycoherbicides offer a potential alternative but are currently unproven and riskier to introduce than traditional insect controls.

Biocontrol is considered a potential alternative, or way to reduce pesticide use, but may take years or decades to be realised. If the past provides a window into the future, the benefits of biological control are more about the reduction of the vigour or spread of the weed rather than its elimination. Therefore, this may lead to a decrease in pesticide use rather than a replacement for it. This is because:

- Biological control methods alone are not currently reliable enough for total control that eliminates the need for chemical application
- Biologic controls are often single species selective, yet to control a pre-plant site a range of weed species need to be controlled, so a pesticide like glyphosate needs to be applied.
- The use of introduced biological control agents is not without risk, and government agencies require exhaustive evidence before approval for field trials. For example, since the establishment of NZ's Environmental Risk Management Agency (ERMA), introductions of new biological control species have slowed due to the consultative processes and rigorous screening procedures that must be completed before a control species is permitted for use.
- Biological controls need to hit a critical mass and operate under optimal conditions before seeing noticeable differences to the weeds or to their geographical spread.

Alternative Chemicals

There is no alternative agrichemical registered for use in NZ, and not designated by FSC as HHP, that can be used instead of glyphosate.

If in future a new alternative agrichemical is found, the regulatory approval for the introduction and use of new pesticides in NZ is very slow and expensive. The Australian and New Zealand forest industries are a tiny consumer of pesticides in global terms. The process for developing alternatives and the associated regulatory conditions reduce the likelihood that new and more acceptable pesticides will be available for the forest industry in the near future.

Summary

The challenge is finding non-herbicide weed control or alternative chemicals that are safer for people and environment, more reliable, operationally as consistent, or as economically cost-effective. Until one is found, there will still be a dependence on agrichemicals for weed control.

Unfortunately, the goal of absolute elimination of pesticide use or even elimination of HHPs, including glyphosate, may not be viable NZ plantation management for many decades. FSC has recognised some of these challenges and section 1.2 and 4.2 of the pesticides policy state:

'1.2 FSC recognizes that in certain circumstances, and after having considered other available pest management strategies and practices, the use of chemical pesticides may be the only feasible way of controlling a pest, weed or disease.'

'4.2 In certain instances, a more hazardous alternative may present lower social and environmental risks than a less hazardous option.P.20 pesticides policy'.

ESRA Part A: Hazards and Exposure Elements

It is a fundamental of the ESRA to understand how glyphosate creates hazards for specific exposure elements, to what level, and how these can be reduced, replaced or removed. Therefore, it is essential to carefully determine the type and level of risk so that when glyphosate is used, the correct mitigation measures are put in place.

The FSC Pesticide Policy in Annex 2 provides explicit guidance on the way the ESRA needs to be laid out. This includes required completing a template hazard and exposure table or matrix 'Identification and assessment of risk – function of toxicity and exposure- and mitigation strategies to minimize it'. The matrix in Table 1 provides an overview only. The detail within the matrix is embedded in the report, or where the amount of detail would otherwise overwhelm the body of the report, it is in an appendix. The relevant appendices are:

- Appendix 1: Glyphosate and Acute/Chronic Toxicity - Summary of National and International Reviews
- Appendix 2: Glyphosate and Soil and Water - Summary of Reviews
- Appendix 3: Glyphosate and Aquatic and Terrestrial Biota - Summary of Reviews
- Appendix 6: Material Safety Data Sheets (SDS) for Glyphosate – Australia/NZ, EU and the USA

Table 1: Identification and Assessment of Risk – Function of Toxicity and Exposure - and Mitigation Strategies to Minimize It

Exposure elements	List of values	Hazard groups and types of hazards ^{1,2}									Descriptor of why / why not a risk ³	Mitigation strategies defined to minimise risk ⁴
		Acute toxicity		Chronic toxicity				Environmental toxicity				
		Toxic by contact or ingestion	Toxic by inhalation	Carcinogenicity	Mutagenicity to mammals	Developmental and reproductive toxicity	Endocrine disruptor	Acute toxicity to aquatic organisms	Persistence in soil and water	Biomagnification - bioaccumulation		
Environmental	Soil erosion and degradation	Na	Na	Na	Na	Na	Na	Low	Low	Na	Weight of evidence indicates there is a low risk of glyphosate affecting erosion if used according to the label and good practice standards as glyphosate is broken down by bacteria in the soil (50% within 8 days). An area of risk is where road cuts and fills are sprayed and re-vegetation measures established at construction are killed off, especially those on recently constructed roads and landings in the erosion-prone hill country. Unlikely that rain-triggered erosion could elevate levels of glyphosate bound sediment if it got into water bodies.	Highly unlikely that fresh earthworks would be sprayed with glyphosate as there will be little or no vegetative cover. Pay attention to the timing of the operation. Evaluate both short term weather to ensure the pesticide is absorbed in the vegetation and not washed off by rain or dew and that the longer-term forecast does not identify events that could lead to erosion and sediment from the application site.
	Soil carbon storage	Na	Na	Na	Na	Na	Na	Na	Na	Na	There are no foreseen risks associated with soil carbon. Studies have generally reported minimal impacts on litter decomposition, soil microbial communities and soil microbial processes, factors that could impact soil carbon, from glyphosate applied under typical application rates in forests.	Weight of evidence indicates that there are no foreseen risks, so no mitigation strategies are anticipated.
	Soil biota	Low	Low	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	There is a low risk of glyphosate affecting soil biota. Studies have generally reported minimal impacts from glyphosate applied under typical application rates in forests, on litter decomposition, soil microbial communities and soil microbial processes. However, it is solely noted on the Australia/NZ SDS that ‘Microbial degradation is the major cause of loss from soil with the liberation of carbon dioxide.’ This may be the case in agricultural soils where the product is used seasonally and not once or twice in a rotation.	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA. Focus on practice standards that help keep application rates at, or below, manufacturers label rates like timing for optimum pesticide effectiveness. Generic mitigation strategies are within the mitigation section of the ESRA.
	Water (groundwater, surface water, water supplies)	Na	Na	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	Weight of evidence indicates there is a low risk of glyphosate affecting water if used according to the label and good practice standards. The breakdown of glyphosate in forest floor litter and soils is generally rapid (litter: DT50 8 to 19 days; soil: DT50 5 to 40 days) and glyphosate is rarely detected below the upper 15 cm level of soils indicating that it is very unlikely to percolate down through forest soils and into groundwater. However, glyphosate can potentially enter freshwater either from direct spray or spray-drift or accidental spillage if storage or load zone is poorly located.	Many practice standards are involved around precision spraying around water. Some are listed below. Refer to the generic mitigation strategies within the mitigation section of the ESRA for additional ones. For example, ensure the pesticide gets applied solely to the application area and that run-off or sedimentation from rain is eliminated. Also, use operators with proven track records and methods that help keep application rates at, or below, manufacturers label. Also refer to the health and welfare, social and infrastructure sections below for additional mitigation.
	Atmosphere (air quality, greenhouse gases)	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na	Glyphosate has no foreseen risks to the atmosphere. Aerial spraying will result in application area having pesticide in the air until the spray settles.

	List of values	Hazard groups and types of hazards ^{1,2}									Descriptor of why / why not a risk ³	Mitigation strategies defined to minimise risk ⁴
		Acute toxicity		Chronic toxicity				Environmental toxicity				
		Toxic by contact or ingestion	Toxic by inhalation	Carcinogenicity	Mutagenicity to mammals	Developmental and reproductive toxicity	Endocrine disruptor	Acute toxicity to aquatic organisms	Persistence in soil and water	Biomagnification - bioaccumulation		
	Non-target vegetation	High	Na	Na	Na	Unlikely	Na	Na	Na	Unlikely	Glyphosate is a non-target herbicide. Spray contact with non-target vegetation could be severely affected. This will depend on the amount of drift and the sensitivity of the species to glyphosate.	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA. Non-target application of glyphosate is one of the largest potential risks when working next to neighbouring properties. Be particularly vigilant when aerially spraying especially around communication and timing of application. It is preferred practice to offset boundary spraying with a ground application if aerial spraying is intended for the block.
Non-target terrestrial wildlife, bees and the other pollinators, pets	Low	Low	Unlikely	Unlikely	Unlikely	Unlikely	Na	Low	Unlikely	There is little information available on forest terrestrial fauna. However, they are potentially at risk through a direct spray, spray drift or wash-off following rainfall events, and uptake via inhalation and absorption. Amphibians are particularly vulnerable. Secondary exposure is also possible through the ingestion of flora and fauna food sources containing glyphosate residues. However, the indicators for toxicity are listed as ‘non-toxic’: honeybees (arthropods), duck and quail (birds), earthworms (soil organisms). Where there are hives in the forests, care will need to be taken especially in roadside spraying operations where clover or other flowering plants have been used in the oversowing blend.	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA. Focus on practice standards that help keep application rates at, or below, manufacturers label rates like timing for optimum pesticide effectiveness.	
Non-target aquatic wildlife	Low	Na	Unlikely	Unlikely	Unlikely	Unlikely, Possible for Hochstetter’s & Archys frogs	Low	Low	Unlikely	<p>Glyphosate is toxic to aquatic life with long-lasting effects. However, forest field studies indicate that the concentrations and duration of glyphosate typically measured, except for direct over-spraying of wetlands, were well below the standard toxicity endpoints for fish and other aquatic organisms. Some studies indicate that the surfactant added to glyphosate to improve efficacy could have significant impact to aquatic wildlife like frogs and tadpoles. Avoid or be highly selective of the surfactant.</p> <p>Refer guidance on Hochstetter’s and Archys frogs at https://rarespecies.nzfoa.org.nz/species/hochstetters-frog/</p>	<p>Meet the requirements of the generic mitigation and monitoring measures section of the ESRA. The risk of glyphosate over-sprayed on waterways will significantly where there are incised gullies with low-order streams that are difficult to detect or avoid during aerial spray applications. Mitigation strategies include ensuring that the map and GPS coverage identifies all waterways and use droplet size that reduces drift.</p> <p>The science has not been undertaken to establish toxicity for NZ native frogs but the application of the precautionary principle cautions on the use of certain surfactants in combination with glyphosate. Mitigation strategies are built into Ernslaw’s <i>Native Frog – ID & Management Summaries</i> (on our National Drive under Environment \ Native (RTE) Species guides) and are adopted where ever native frogs are known to exist .</p>	

	Non-timber forest products (as FSC-STD-01-001 V5-2 FSC principles and criteria, criterion 5.1)	Low	Na	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	Low risk as glyphosate is used regularly and extensively in food production. For specifics, if the non-timber product is a plant crop, refer to the risks within the non-target vegetation. If the non-timber product is aquatic, refer to the risks within non-target aquatic mitigation. If the non-timber product is terrestrial, refer to the non-target terrestrial risk section above.	If the non-timber product is a plant crop, refer to the requirements within the non-target vegetation. If the non-timber product is aquatic, refer to the non-target aquatic mitigation. If the non-timber product is terrestrial, refer to the non-target terrestrial section above.
	List of values	Hazard groups and types of hazards ^{1,2}									Descriptor of why / why not a risk ³	Mitigation strategies defined to minimise risk ⁴
		Acute toxicity		Chronic toxicity				Environmental toxicity				
		Toxic by contact or ingestion	Toxic by inhalation	Carcinogenicity	Mutagenicity to mammals	Developmental and reproductive toxicity	Endocrine disruptor	Acute toxicity to aquatic organisms	Persistence in soil and water	Biomagnification - bioaccumulation		
	Landscape (aesthetics, cumulative impacts)	Low	Low	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	The risk to landscape is low. However, the risk increases with scale and intensity. For example, large aerial sprayed areas could increase the hazard, especially if bordering neighbouring properties that could include DoC forest or National parks.	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA. Non-target application of glyphosate is one of the largest potential risks when working next to neighbouring properties. Be particularly vigilant when aerially spraying especially around communication and timing of application. It is preferred practice to offset boundary spraying with a ground application if aerial spraying is intended for the block.
Ecosystem services (water, soil, carbon sequestration, tourism)	Na	Na	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	The risk is low; however, specific circumstances could increase risk. Refer to the individual risk sections for water, soil, carbon sequestration, and tourism.	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA. Refer to the individual mitigation sections for water, soil, carbon sequestration, and tourism.	

Exposure elements	List of values	Hazard groups and types of hazards ^{1,2}									Descriptor of why / why not a risk ³	Mitigation strategies defined to minimise risk ⁴
		Acute toxicity		Chronic toxicity				Environmental toxicity				
		Toxic by contact or ingestion	Toxic by inhalation	Carcinogenicity	Mutagenicity to mammals	Developmental and reproductive toxicity	Endocrine disruptor	Acute toxicity to aquatic organisms	Persistence in soil and water	Biomagnification - bioaccumulation		
Social	High conservation values (especially HCV 3 – rare, threatened or endangered ecosystems, habitats or refugia)	Na	Na	Na	Na	Possible for Hochstetter’s & Archys frogs	Na	Na	Na	Na	Refer guidance on Hochstetter’s and Archys frogs at https://rarespecies.nzfoa.org.nz/species/hochstetters-frog/	The science has not been undertaken to establish toxicity for NZ native frogs but the application of the precautionary principle cautions on the use of certain surfactants in combination with glyphosate. Mitigation strategies are built into the Ecological mitigation for Whangapoua, and should be adopted where ever native frogs are known to exist.
	Health (fertility, reproductive health, respiratory health, dermatologic, neurological and gastrointestinal problems, cancer and hormone imbalance)	Low	Low	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	FSC categorises glyphosate as highly hazardous due to its potential as a carcinogen. However, the weight of evidence indicates that there are unlikely to be any health-related hazards if used according to the label and good practice standards. Most studies report that there is no, or unlikely carcinogenic or genotoxic risk to humans at anticipated exposures. Views aren’t consistent, for example, those of PAN. Refer https://www.pan-uk.org/glyphosate/	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA. Meeting high personal care, material handling and pesticide application standards and health check requirements are essential. Generic mitigation strategies are within the mitigation section of the ESRA. These include health-specific mitigations like ensuring the contractor has read and fully understood how to apply glyphosate and the Personal Protective Equipment (PPE) requirements for it, the health and safety and environmental emergency procedures are well understood, and all PPE is on-site, in good condition, and correctly used*
	Welfare	Low	Low	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	Welfare has been assessed the same as health since health (and happiness) are key components of welfare. Weight of evidence indicates that there is unlikely to be any health-related hazards if used according to the label and good practice standards. Most studies report that there is no, or unlikely carcinogenic or genotoxic risk to humans at anticipated exposures. Views aren’t consistent, for example, those of PAN.	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA. Meeting high personal care, material handling and pesticide application standards and health check requirements are essential.
	Food and water	Low	Low	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	Weight of evidence indicates there is a low risk of glyphosate affecting food and water if used according to the label and good practice standards. An area of risk is through accidental or ongoing oral ingestion by pesticide workers on-the-job poor personal hygiene around food and drink. Also, poor application timing before heavy rain or direct spray over water may increase the likelihood of broader risk to water. Forest products have a much lower risk profile compared with normal food crops. Glyphosate in Aust/NZ has not been recorded in drinking water and food other than at factors of levels below what is considered unsafe.	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA. Meeting high personal care, material handling and pesticide application standards and health check requirements are essential. Generic mitigation strategies are within the mitigation section of the ESRA.
	Social infrastructure (schools and hospitals, recreational infrastructure adjacent to the management unit)	Low	Low	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	Poor practice can lead to significant risks like spray drift killing crops and contaminating water contamination. Recreation could be impacted, see rights section below.	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA which includes managing operations around adjacent properties and communication with potentially affected parties will mitigate risks. Take particular care and initiate additional operational conditions, if necessary, around water reservoirs, neighbours water intakes within the forest boundary, or around public forest recreational activities e.g. mountain bike tracks, or other potentially riskier sites.

	List of values	Hazard groups and types of hazards ^{1,2}								Descriptor of why / why not a risk ³	Mitigation strategies defined to minimise risk ⁴
		Acute toxicity		Chronic toxicity			Environmental toxicity				
		Toxic by contact or ingestion	Toxic by inhalation	Carcinogenicity	Mutagenicity to mammals	Developmental and reproductive toxicity	Endocrine disruptor	Acute toxicity to aquatic organisms	Persistence in soil and water		
	Economic viability – other primary sector	Low - High	Low	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	There is always a potentially significant risk when aerial spraying next to boundaries. Glyphosate overspray could have an economic impact to adjoining horticulture leading to costly compensation or legal action. Glyphosate is a non-target pesticide so sensitive crops can easily be killed or browned off. Organics (Bio grow certified farms) and vineyards may be especially vulnerable.
Economic viability - tourism	Low	Low	Unlikely	Unlikely	Unlikely	Unlikely	Low	Low	Unlikely	The risk to tourism can be both internal and external. Internal tourism would include in-forest mountain bike riding, horse trekking, and hunting. External would include adjoining DoC forests or national parks. Glyphosate is a non-target pesticide so will kill or brown-off all species that are sensitive to it.	Meet the requirements of the generic mitigation and monitoring measures section of the ESRA which includes managing operations around adjacent properties including communication with potentially affected parties will mitigate risks. It is essential to discuss the operation thoroughly in-house between the different management teams that may be involved. It is also critical to discuss the pesticide application with neighbours. It is preferred practice to offset boundary spraying with a ground application if aerial spraying is intended for the block.
Other											
<p>1 = Weight of evidence base. ‘Unlikely’ means there is not a unanimous agreement between assessment organisations but a general agreement. For example, almost all international government agencies disagree with the WHO’s IARC 2015 categorisation of glyphosate as a “probable carcinogen”. Evidence based means that "Unlikely" has been entered in the carcinogenicity column even though the FSC has categorised glyphosate as highly hazardous due to carcinogenicity.</p> <p>2 = The risk associated with the hazard is based off using glyphosate under the label and regulatory requirements.</p> <p>3= The appendices provide additional information.</p> <p>4 = Refer to 4.12 (2) section of this ESRA for general mitigation requirements</p>											

ESRA Part B: Scale, Intensity and Risk

Scale	A measure of the extent to which a management activity or event affects an environmental value or a management unit, in time or space. An activity with a small or low spatial scale affects only a small proportion of the forest each year, an activity with a small or low temporal scale occurs only at long intervals (Source: FSC 2011).
Intensity	A measure of the force, severity or strength of a management activity or other occurrence affecting the nature of the activity's impacts (Source: FSC 2011).
Risk	The probability of an unacceptable negative impact arising from any activity in the Management Unit combined with its seriousness in terms of consequences (Source: FSC 2011).

Source: FSC-STD- 01-001 V5-2 EN

Scale, Intensity and Risk (SIR) is cited extensively within FSC's Principles and Criteria, and it is also an important consideration in an ESRA.

Glyphosate is used for many forestry operations across a wide range of scales, with different intensities and risk profiles. The risk profile will change depending on how it is applied, the size of the treatment area and the risks within, and external, to the site.

- Scale: Operations range from small operations comprising of a fraction of a hectare to large ones covering hundreds of hectares
- Intensity: Glyphosate is applied by hand with a backpack spray unit, by small vehicles with a tank, reel and handheld spray nozzle, vehicles with spray booms, or broadscale helicopter application
- Risk: Spot spraying over small areas has limited risk; however, risk across all exposure variables will likely increase significantly for large scale aerial applications in the steep hill country with rapidly changeable weather.

In Australia and New Zealand, glyphosate is applied in the following operations:

- Pre-plant and post-plant (with shield) spot spray
- Pre-plant desiccation (aerial and or ground based machine)
- Weed control around infrastructures like buildings, roadsides, Fire dams and other sites
- Coppice control (stump application and or ground based machine)
- Wilding or pest tree control (drill/cut-stump and paste)
- General noxious weed control (by hand or ground vehicle)

The requirements of the ESRA (in 4.12 (6)) require that 'before applying any chemical pesticide, incorporate the results of their ESRA to site operational plans, to identify site-specific risks and adapt the generic mitigation and monitoring measures previously identified in the ESRA (Clause 4.12.2).'

A vital goal of this report is to provide generic mitigation requirements that will be applicable across all scale, intensity and risk. The following section details this mitigation. Some conditions are solely for aerial applications and generally, are identified as such, but most are across all SIR.

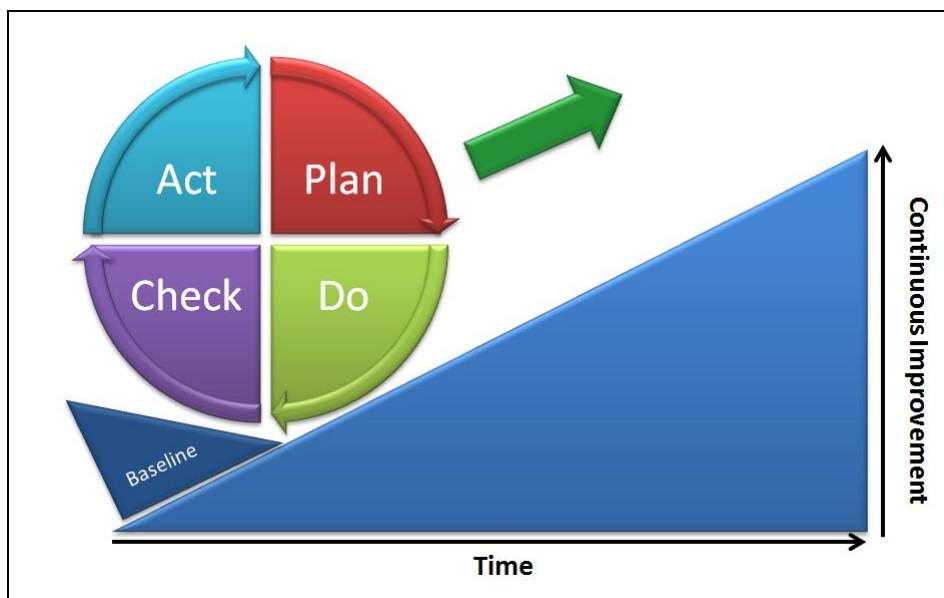
The level of detail to assess a small spot spray job or a roadside weed spray will be minor compared to a broadcast extensive aerial treatment. Some of the generic mitigation or monitoring requirements are not necessary for some jobs. Rather than have a series of mitigation requirements by operational type, intensity and risk profile, it is simpler to go through a standard generic checklist.

ESRA Part C: Generic Mitigation and Monitoring to Minimize Risks

The mitigation and monitoring measures reflect the broad range of mitigation requirements identified in the hazard and the exposure elements matrix, and the broader regulatory environment.

Most of the list of requirements are already considered current forestry good practice in Australia and New Zealand.

The mitigation and monitoring measures are covered in the order operations are carried out in the improvement cycle – plan, do, check and where necessary act.



The exposure variables are incorporated into the mitigation and monitoring requirements. Whenever they are included, there is a superscript asterisk (*) notation.

A summary table below, has been produced to help keep track of whether the exposure variables and elements have addressed the mitigation requirements within the above matrix. This follows the generic mitigation and monitoring measures to minimise the risks.

Pre-operational Planning

Develop an operational plan*

Ernslaw staff will follow procedures in our Silvi manual to:

- Decide on the scale of treatment area*
- Complete both an office and field-based planning process to assess site hazard and risks, and provide ground-truthing
- Assess the sensitivity of the off-target vegetation
- Determine the application method*
- The field map must show spray/no spray areas and include information on potentially at-risk adjoining property, or environmental features Identify no-fly zones

- Create the plan to ensure the glyphosate stays within the target area and not contaminate other land, water supplies, streams or water bodies
- Determine minimum buffers by application method and buffer type
- Buffer zones will be left to protect water quality, non-target plants and non-target land. Buffer widths will be commensurate with the potential risk and consequences.

Document in Silvicultural Manual form 8A – Site Preparation and Weed Control Assessment Form.

Meet legal requirements

Ernslaw staff will follow procedures in our Silvi manual to:

- Comply with regulatory requirements, both Regional and national, and meet FSC requirements for chemical use.

Select formula and rates*

Ernslaw staff will follow procedures in our Silvi manual to:

- Use non-pesticide methods of weed control in preference to glyphosate where effective, practical and financially prudent, as consistent with chapters 8 & 16 of Ernslaw Silviculture manual – Ch 8: Weed Control and Ch 16: Pest control including our Integrated Pest Management Strategy.
- Aim for pesticide applications to coincide with optimal plant uptake
- Follow approved product label instructions
- Use application rates below the manufacturers label rates, where still effective and legally possible
- Target pesticide only on required areas
- Consider soil properties and erosion in the treatment area
- Decide on the type and rate of application method, including the:
 - Formulation (type and components)*
 - Concentration of the active ingredient(s)*
 - Dose of the active ingredient(s)*
 - Mixture of active ingredients (composition and mixing process)*
 - Metabolites of the active ingredient*
 - Frequency and interval of application*
 - Note if there have been other pesticide applications*
- When reviewing our Silviculture manual, check the online FSC database for information on alternatives and monitoring procedures*
- our Silviculture manual must refer to our ESRA process, because this manual drives the development of our silviculture prescription and our operational maps*
 - update Document 8G in the Ernslaw Silvicultural manual (Prescription For Aerial Spraying),

Training, competencies, and job responsibilities requirements*

Ernslaw Regional Managers or a person with their delegated authority will ensure that:

- staff involved with planning, managing and or undertaking the operation need to be trained and contactors have the appropriate certificates or approvals

- Staff must understand which agrichemicals have been designated by FSC as Highly hazardous (by reference to Chapter 8 of our Silvi manual which in turn draws from this ESRA).
- only experienced contractors with suitable qualifications, current licenses, and demonstrated competency are employed.
- Individual staff, contractors and their employees understand their responsibilities in the operation.

Undertake pre-operation consultation with neighbours and community (if treatment area adjoins property boundary or operation could impact)

Ernslaw's Silvicultural manual requires that operations supervisor or forest manager will follow procedures in our Silvi manual to:

- Send written notification to neighbours adjacent to the operation and potentially affected stakeholders before any operation starts
 - refer to Ernslaw Silvicultural manual section 8.6.1, which requires:
For aerial operations a public notice will be placed in local newspapers at least two weeks prior to the application and any adjoining owner who has property within 500 metres of the area being treated must be contacted. For ground-based boom or gun spraying operations any adjoining owner who has property within 100 metres of the area being treated must be contacted. For spot releasing operations, contact is required with adjoining owners within 50m of the operation.
 - Note also that the NZFOA MoU with Federated Famers (Signed 2013⁸) commits Ernslaw as FOA member to a number of actions, including
 - 2.5. Where either neighbour adopts organic or similar land management practices that preclude the use of commonly used herbicides on their land and notifies the adjoining neighbour of this, both neighbours acknowledge the difficulty of controlling pest plants on the non-planted boundary of a plantation, and will work together to find the best practicable means of minimizing growth of such plants. That may mean reliance on spot spraying or planting closer to the boundary to suppress weeds. It is recommended any agreements between neighbours are recorded in writing.
- Post notices to inform the local community if non-timber products like blackberries may have been sprayed in publicly accessible forest areas
- Consider a no aerial spray buffer when a school or residential building or commercial yard, surface water intake or water well is immediately adjacent to the treatment area. Instead, treat with ground application methods.

Ernslaw's EPP team will ensure that the ESRAs and the operational plans are made available to interested stakeholders upon request (All ESRAs will be available on our Intranet and on our public website under Forestry / Environmental Management⁹)

⁸ <http://www.nzfoa.org.nz/resources/file-libraries-resources/agreements-accords/529-memorandum-of-understanding-foa-ffa-and-federated-farmers/file>

⁹ <https://www.ernslaw.co.nz/environmental-management/>

During Operations

Operational briefing and sign-off plan

Ernslaw will have a Silvicultural supervisor or Forest manager on site as per procedures in our Silvi manual to:

- Complete a pre-operational briefing and induction to confirm the operational area and operational requirements. Document in the applicable forms from Ernslaw Silvicultural manual as follows:
 - 8B (Weed Control Operation Checklist),
 - 8E (Operational Spray Plan – Treatment Areas for Roads/Boundaries)
 - 8H (Work Specifications – Aerial Spraying),
 - 8O (Work Specifications for Road Maintenance)
- Ensure the site operational plan and map (prescription) is agreed and understood by all and signed off by the contractor.

Health and safety and hazard identification*

Ernslaw's Silvicultural manual has systems to ensure that work cannot start until the contractor has signed-off the prescription

Ernslaw will have a Silvicultural supervisor or Forest manager on site whose task it is to:

- Ensure contractors have read and fully understood how to apply glyphosate and the PPE requirements for it
- Involve the contractor with site hazard identification and mitigation
- Ensure the health and safety and environmental emergency procedures are well understood
- Ensure all Personal Protective Equipment (PPE) is on-site, in good condition, and correctly used*
- Follow the product label and SDS
- Current SDS must be on-site, accompanying pesticides transported, and also kept at chemical storage locations
- Decide on signage needed and install for the operation
- Shut down the operation immediately if the contractor breaches the requirement of the prescription
- Have handwashing facilities and separate drinking water available on-site
- Ensure a first aid kit is available at transport, storage and application sites
- Explain first aid measures the glyphosate SDS requires (from Aust/NZ SDS):
 - Inhalation: If inhaled, move the person to fresh air. Keep at rest in a position comfortable for breathing until recovered. Get medical advice if symptoms persist. If the person is not breathing, seek immediate medical assistance and give artificial respiration. Follow up with medical personnel to ensure that the incident is recorded in the NZ Public Health Surveillance database "HSDirt"¹⁰.
 - Ingestion: Do not induce vomiting. Rinse mouth with water. Get immediate medical advice.
 - Skin: Wash affected area with plenty of soap and water. If irritation persists or develops, get medical advice

¹⁰ <https://www.ehinz.ac.nz/our-projects/hazardous-substances/hsdirt-notification-tool/>

- Eye contact: Hold eyelids apart and flush continuously with water several minutes. Remove contact lenses if present, continue rinsing for more than 5 minutes. If irritation persists or symptoms develop, seek immediate medical attention
- The health of workers exposed to glyphosate where annual exposure to spray drift exceeds 16 hours (2 work days) will be monitored, ensuring that the contractor has record storage systems for 30 years (as is now required by law) ¹¹.

Staff will refer to Silvicultural manual form 8Q – Chemical Handlers/Applicators Questionnaire, which will be followed up on annually by Ernslaw’s National Health and Safety Manager.

Clear operational areas of non-authorised people

Ernslaw’s Silvicultural supervisor or Forest manager will follow procedures in our Silvi manual, which ensures that the operational area is clear of non-authorised people, especially near aerial operations.

Processes should include:

- Installing signs or notices at suitable locations on roads and tracks leading to the target areas to warn the public of aerial operations
- Creating road blocks (signage or closure tape)
- Carry out a reconnaissance flight over the target areas if aerial treating.

Transport and storage

Ernslaw’s Silvicultural supervisor or Forest manager will ensure that the contractor follow procedures in our Silvi manual to:

- Park or stores chemicals safely away from ditches, water bodies and riparian zones to avoid contamination of waterbodies
- Securely and safely transport pesticide to the operational area
- Transports, handles and stores chemicals according to label instructions, SDS and other regulatory requirements¹²
- Stores pesticides in a chemical shed or secure, weatherproof location that meets regulatory requirements
- Don’t leave pesticides unattended on-site unless locked, secured and in a safe area.

Mixing and loading sites

Ernslaw’s Silvicultural supervisor or Forest manager will ensure that the contractor or wage worker follows procedures in our Silvi manual to:

- Mix to specification

¹¹ The Health and Safety at Work (general risk and workplace management) Regulations 2016 require that PCBU’s undertake health monitoring when workers are exposed to hazardous substances, and that records are kept for 30 years. Refer <https://worksafe.govt.nz/dmsdocument/1844-health-monitoring-under-the-health-and-safety-at-work-general-risk-and-workplace-management-regulations-2016>

¹² Schedule 1 of the Land Transport Rule: Dangerous Goods (2005) requires a driver to have a dangerous goods (D) licence endorsement to transport of more than 1000 litres of substances that are toxic to the aquatic environment (UN 3077 or UN 3082), packaging group 3 (low danger), which captures glyphosate.

- Measures accurately and without spillage
- Uses clean water free of contaminants. Contaminants like dirt or rust will affect calibration by reducing nozzle flow or droplet size
- Selects mixing sites where spills can be contained, and will not directly enter a ditch, waterbody, riparian zone or reserves
- Doesn't load or mix herbicide at tank refilling locations
- Ensures when filling a tank that back-syphoning from the tank cannot occur
- Disposes of wastewater from cleaning storage tanks, equipment and containers safely away from ditches, water bodies and riparian zones.
- Never dumps a load or a tank mix
- Containers are be disposed of appropriately off-site. The preferred method is to recycle via the chemical suppliers, drum-muster or agri-recovery sites. Refer to guidance for contractors on waste management and recycling on the Ernslaw web site, under Agr-recovery:
www.ernslaw.co.nz/waste-management-recycling-and-recovery/
- Ensure materials are on site to clean up or contain a spill.

Calibration of equipment

Ernslaw's Silvicultural supervisor or Forest manager will ensure that the contractor or wage worker follows procedures in our Silvi manual to:

- Calibrate application equipment before starting work and during operations to ensure uniform and accurate distribution over the area, and for aerial spraying check that the operator has the AirCare current accreditation list, or via an equivalent third-party certification.
www.aia.org.nz/AIRCARE/AIRCARE+Accredited+Organisations.html
- Have QA processes in place that allow a check that usage matches hectares treated.

Weather and climatic conditions*

Ernslaw's Silvicultural supervisor or Forest manager will follow procedures in our Silvi manual to:

- ensure that treatment does not begin unless conditions are within operational parameters
- Suspend all, or part of the program, if weather conditions or other factors are not optimal
- Undertake regular monitoring of weather conditions. These must meet application parameters or else the operation needs to be immediately shut down
- Continue treatment only if weather conditions are within the application parameters for maximum wind speed, wind direction, no rainfall, no inversion layer (surface or other), no cold air drainage, soil moisture, air temperature and relative humidity
- If aerial spraying, include additional specific application requirements - monitoring airspeed, release height and flight direction, and document in Silvicultural Manual form 8I – Aerial Spraying – Weather Recording

Apply Pesticide only to the treatment area*

Ernslaw's Silvicultural supervisor or Forest manager will follow procedures in our Silvi manual to

- Treat all areas identified for treatment within the operational boundary
- Ensure an even distribution over the treatment area or as specified

- Ensure complete coverage of the treated area. Consider using effective marking systems (e.g. dye or foam) or electronic guidance systems
- Additional aerial spraying specific application requirements include:
 - Carry out the aerial application only by helicopter
 - Use only helicopters equipped with an on-board computer to monitor the chemical flow rate and give precise in-flight management of the application system.
 - Use only application system must have precise cut-off and no-drip nozzles.

Prevent leaching and spray drift *

- Ensure conditions are optimal for the job to start and within specification limits
- Ensure there is no risk of off-site damage by leaching or spray drift outside of the target area
 - Don't treat restricted areas or buffers
 - Don't contaminate any water supply, permanent or temporary stream, wetlands or other water bodies.
- Stop treatment or increase buffers where there is a downwind spray drift risk
- Use appropriate nozzles and pressures to reduce the risk of off-site impacts.
- Pesticide must not contaminate water supplies, or water bodies like streams, lakes or dams.

Social responsibility and care during operations (neighbours and community)*

- Notify neighbours adjacent to the operation, or potentially affected parties that need to be contacted on the day of operation
- Locate mixing sites and helipads away from neighbouring properties
- Don't fly loaded helicopters over adjacent ownership
- No aerial application if target areas are near a school, public playground, council reserves, Conservation land and national park, or municipal water reservoir. Prudently use ground applications along the adjoining boundary.
- No glyphosate application within a Streamside Management Zone or a Riparian Management Zone unless to control exotic-invasive species and only if the treatment doesn't impact erosion or water quality.

Contain spills*

- Have an emergency spill kit or spill containment system available suitable for the quantity and type of chemical being stored and used
- Dispose of contaminated material responsibly and legally (location determined by spill size) well away from any ditch, waterbody, riparian or reserve.

Keep operational records*

- Keep the following records that FSC requires for the ESRA:
 - Product trade name*
 - The application rate of the product*
 - Date & time product was used*
 - Name and address of the applicator/supervisor*
 - Crop or situation that was treated*

- Location where the product was used*
- Area of land treated*
- Weather details (previously listed)*.

Refer to Ernslaw Silvicultural Manual form 8P (Chemical Use – Post Operation Sign-Off).

Post Operational Monitoring

- Assess coverage of the operation, e.g. through visual checking for dye or through comparing electronic tracking performance against operational boundaries
- Check coverage to identify any areas of overspray or spraying outside boundaries
- Measure indicators of success including spray efficacy and no off-target adverse effects
- Undertake water sampling and analysis for chemical residues on high-risk sites to monitor the effectiveness of buffers & other protection measures
- Establish and monitor pesticide applicators health. The National Health and Safety Manager is to follow up on returns from Silviculture manual Form 8Q – Chemical Handlers/Applicators Questionnaire.

Improving Operational Effectiveness

- Promote log levy funding for research to identify and test alternatives to replace FSC highly restricted HHPs and restricted HHPs with less hazardous alternatives*
- Programmes will usually be organized collaborative with other companies or research organisations through the NZ FSC Economic Chamber Cluster Group.
- Levy funded programmes have clear actions, timelines, targets and resources allocated*

Summary Table That Links Mitigation Actions with Exposure Variables

Mitigation group ¹ (see mitigation section for specific tasks)	Exposure variable																	
	Soil erosion	Soil carbon storage	Soil biota	Water	Atmosphere	Non-target vegetation	Non-target terrestrial wildlife	Non-target aquatic wildlife	HCV (esp. HCV 1-4)	Landscape	Ecosystem services	HCV (esp. HCV 5-6)	Health	Welfare	Food and water	Social infrastructure	Economic – primary sector	Economic – tourism
Develop an operational plan*	•	Na	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Meet legal requirements		Na		•	•	•							•	•	•	•		
Select formula and rates*		Na		•									•	•	•	•		
Meet training, competencies, and job responsibilities requirements*	•	Na	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Undertake Pre-operational consultation with neighbours and community (if treatment area adjoins property boundary or could impact*)	•	Na		•	•	•	•	•		•	•	•	•	•	•	•	•	•
Operational briefing and sign-off plan	•	Na	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Health and safety, and hazard identification*	•	Na	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Clear operational areas of non-authorized people		Na											•	•				
Transport and storage		Na		•				•					•	•	•			
Mixing and loading sites		Na		•				•					•	•	•			
Calibration of equipment		Na	•	•				•			•							
Weather and climatic conditions*	•	Na		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Apply pesticide only to the treatment area*	•	Na		•		•	•	•	•	•	•	•	•	•	•	•	•	•
Prevent leaching and spray drift *	•	Na		•		•	•	•	•	•	•	•	•	•	•	•	•	•
Social responsibility and care during operations (neighbours and community)	•	Na		•		•	•	•	•	•	•	•	•	•	•	•	•	•
Contain spills*		Na		•									•	•	•	•		
Keep operational records*	•	Na	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Post op monitoring		Na				•	•	•	•		•	•		•	•	•	•	•
Improve operational effectiveness*	•	Na	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

* = The exposure variables have been incorporated into the mitigation and monitoring requirements. Whenever they are included within a mitigation group there is a superscript asterisk (*) notation.

1 = Format follows the operational cycle: 1) pre-op plans, 2) operational controls, 3) post-op monitoring and 4) review

ESRA Part D: Described the Hazards, Exposure Elements and Exposure Variables

The FSC pesticide policy's Appendix 2 incorporates specific hazards, exposure elements and exposure variables into the ESRA. This section confirms that the minimum requirements meet 4.12 (3).

The hazard and exposure matrix included all the required components and some additional variables. Several exposure elements were split into individual parts to improve clarity rather than aggregated as in the hazard and exposure matrix.

This ESRA has incorporated the FSC exposure variables into the mitigation and monitoring requirements, and the matrix. A superscript asterisk (*) notation denotes where they are included to help ensure compliance with Annex 2's list.

The FSC's required exposure variables are listed below. However, they have been reordered to reflect how they are considered within the mitigation matrix and at the operation level:

Understanding the block and its site features:

- Scale of treatment area.
- Site conditions (e.g., soil type, topography of the area)
- Predicted weather (e.g., wind speed and direction, temperature and humidity for Delta T)
- Potential for spray drift (wind speed and lower atmosphere stability)
- Number of previous applications (as tracked in Geomaster - our stand record system) .

Determining what to spray and if a single application will be effective (in conformance with Section 8 of the Ernslaw Silviculture manual):

- Formulation (type and components)
- Concentration of the active ingredient(s)
- Dose of the active ingredient(s)
- Mixture of active ingredients (composition and mixing process)
- Metabolites of the active ingredient
- Frequency and interval of application.

Deciding how to apply the spray:

- Method of application (e.g., spot, foliar, spray, aerial, broadcast)
- Application system and equipment (e.g. knapsack sprayer, helicopter, drone, plane).

Health and safety, and emergency response

- Capacity and skills of workers (license to handle pesticides, training, ability to read and understand labels and instructions).
- Personal protective equipment
- Emergency related equipment (e.g., first aid, spill kits)
- Waste management systems.

Social and cultural considerations

- Information available to neighbours about pesticides application (e.g. pesticide to be used, timing, risks associated with pesticide use, re-entry period after application).'

An additional summary table was constructed to help show the links between the type of mitigation to the exposure elements.

The current Australian and New Zealand good practice requirements are more complex and detailed than the list of exposure variables within the FSC's pesticide policy. This reflects the complex regulatory requirements, both regional and national, around the application and handling of agrichemicals; health and safety regulations; and the broader expectations of the FSC within its Principles and Criteria around worker safety, community engagement and overall environmental stewardship.

Ernslaw Silviculture manual will be regularly reviewed to ensure that chemical application in our estate complies with the following:

- Code of Practice for the Management of Agrichemicals NZS8409:2004
- Code of Practice for the use of Pesticides in Plantation Forestry Operations
- Transport of Dangerous Goods on Land NZSS433:2012
- NZ Environmental Code of Practice for Plantation Forestry
- Resource Management Act 1991
- Biosecurity Act 1993
- Hazardous Substances and New Organisms Act 1996
- Health and Safety at Work Act 2015, including:
 - Health and Safety at Work (general risk and workplace management) Regulations 2016,
 - Health and Safety at Work (Hazardous Substances) regulations (2017)¹³.
- Regional and District Council Plans including Air, Water and Environment Plans
- National and Regional Pest Management Strategies prepared under the Biosecurity Act 1993
- FSC Principles and Criteria

¹³ In our National Drive under Environment at <\\ernslaw.local\docs\National\Environment\Legislation>

Conform with International and National Indicators and Thresholds for the Use of HHPs

Two international Material Safety Data Sheets (SDSs- appended) were compared against the Australian/NZ equivalents to help identify differences in product disclosure around safety, health and the environment. Monsanto's SDSs were used to help standardize the comparison between Monsanto Australia/New Zealand, Europe and the United States. Australia and NZ SDS are the same because Monsanto Australia has a NZ distributor.

SDSs provide a useful comparison because indicators and thresholds are an integral component of these. Also, there is an international agreement which standardises specification for safety data sheets for direct comparison. SDS are required to follow a 16-section format.

SDS link regulatory requirements to the chemical use as SDS need to meet each country's certifying requirements. For example, Safety data sheets have been made an integral part of the European Union's system of Regulation (EC) No 1907/2006 (Registration, Evaluation, Authorisation and Restriction of Chemicals - "REACH"¹⁴). The European Chemicals Agency (ECHA) has published a guidance document on the compilation of safety data sheets.

The review determined that the three SDSs:

- Base information is the same
- Had minor differences around the description and the level of detail of the base information
- The USA SDS was generally the most detailed
- The EU and USA SDS provides significantly more detail than the Australian/NZ counterpart in the toxicological and ecological sections. However, the Australian/NZ summaries were more succinct without losing the critical message.
- The Australian/NZ SDS is much easier to understand because the layout is simple; it was concise and easy to read due to larger font and subheadings.

Also, a comparison of current good practice between Australia and NZ was made using different company's herbicide application standards because in most instances these have developed independently within each nation's forestry industries. There was strong consistency between pre-operation planning, during the operation, and post-operational controls and assessments. The identification and mitigation of hazards are similar.

¹⁴ <https://osha.europa.eu/en/legislation/directives/regulation-ec-no-1907-2006-of-the-european-parliament-and-of-the-council>

Making our ESRAs Available to Affected Stakeholders Upon Request

This section fulfils the requirement of 14.2(7). It provides a high-level overview of FSC's chemical policy. It helps answer the basic questions around FSC's rules on chemical use, what are HHPs and an ESRA, and why they need doing.

The overview is designed to meet the requirements of the first part 14.2 (7), making the ESRA available to affected stakeholders upon request.

In most instances, the overview would give enough information and detail as a prelude to the operational plan, which provides the specific and in-depth details of the operation including the mitigation measures. If they still wish to see more, then the full ESRA can be supplied.

Appendix 4 gives a template public summary for 'Chemical Pesticide Use in FSC Forests'.

Encourage Third-Party Processing Plants and Nurseries to Avoid HHPs

The pesticide policy requires:

12. Inform third-party processing plants located in the spatial area of the Management Unit (MU) and third-party nursery suppliers of the list of FSC prohibited chemical pesticides, encouraging them to avoid these pesticides in their processes and in the production of seedlings and other materials entering the management unit.
13. Request the list of FSC prohibited chemical pesticides used by processing plants and nurseries suppliers described in clause 4.12.12.'

New Zealand certified companies have committed collectively to send a letter to third-party processing plants and third-party nursery suppliers in fulfilment of the above requirements.

References

FSC® documents

FSC Pesticides Policy FSC-POL-30-001 V3-0 EN

FSC Lists of highly hazardous pesticides FSC-POL-30-001a EN

FSC Principles and Criteria

(all on the Ernslaw Intranet under Environment/FSC and at <https://fsc.org/en>)

Other references

Australian Drinking Water Guidelines 2011. <https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines>

Australian Pesticides and Veterinary Medicines Authority 2016. Regulatory position: consideration of the evidence for a formal reconsideration of glyphosate ISBN 978-1-925390-49-0 www.apvma.gov.au

European Union European Chemical Agency (ECHA) Press Release Helsinki, 15 March 2017 <https://echa.europa.eu/-/glyphosate-not-classified-as-a-carcinogen-by-echa>

Close M, and Humphries B. 2019 National Survey of Pesticides and Emerging Organic Contaminants (EOCs) in Groundwater 2018. ESR
www.esr.cri.nz/assets/National-Survey-of-Pesticides-and-EOCs-in-GW-Report-for-RC-v2.pdf

European Commission 2019. Current status of glyphosate in EU.
https://ec.europa.eu/food/plant/pesticides/glyphosate_en

Ministry of Health 2019. Guidelines for Drinking Water management for New Zealand.
www.health.govt.nz/system/files/documents/publications/dwg-ch10-chemical-compliance-jun19.pdf

Environmental Protection Agency, 2016. Review of the Evidence Relating to Glyphosate and Carcinogenicity.
www.epa.govt.nz/assets/Uploads/Documents/Everyday-Environment/Publications/f2f72882a7/EPA-glyphosate-review.pdf

Environmental Protection Agency, 2020
www.epa.gov/sites/production/files/2020-01/documents/glyphosate-interim-reg-review-decision-case-num-0178.pdf

Pesticide Action Network International 2016. Glyphosate monograph.
<http://pan-international.org/wp-content/uploads/Glyphosate-monograph.pdf>

Rolando C. et al. 2017. The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests. Forests MDPI. www.mdpi.com/1999-4907/8/6/208/pdf

Relyea 2005. The lethal impact of Roundup on aquatic and terrestrial amphibians. Ecological Applications vol. 15. www.nrc.gov/docs/ML1434/ML14345A564.pdf

US EPA 2017. Revised Glyphosate Issue Paper; Evaluation of Carcinogenic Potential/

Ernslaw One ESRA for Glyphosate Version 1.1 April 2020

www.epa.gov/ingredients-used-pesticide-products/draft-human-health-and-ecological-risk-assessments-glyphosate

US EPA 2019 Letter to registrants regarding glyphosate

www.epa.gov/sites/production/files/2019-08/documents/glyphosate_registrant_letter_-_8-7-19_-_signed.pdf

World Health Organisation 2015. International Agency for Research on Cancer (IARC) Monograph on glyphosate. www.iarc.fr/featured-news/media-centre-iarc-news-glyphosate/

Zhang L., Rana L., Shaffer R., Taiolic E. and Sheppard L. 2019. Exposure to glyphosate-based herbicides and risk for non-Hodgkin lymphoma: A meta-analysis and supporting evidence. Mutation Research/Reviews in Mutation Research. Vol 781, pp 186-206.
www.sciencedirect.com/science/article/pii/S1383574218300887

Appendix 1: Glyphosate and Acute/Chronic Toxicity - Summary of National and International Reviews

The summary's purpose is to help fill in the 'identification and assessment of risk' matrix (P.41 Pesticide policy document) around acute and chronic toxicity, health and welfare. It is essential to carefully determine the type and level of risk so that when glyphosate is used the correct mitigation measures can be put in place.

This summary document comprises extracts from major global assessments of glyphosate. These include the three reports used by the FSC to determine carcinogenicity. It follows a timeline because when a report was issued is important since new information comes to light, and previous assessments can be reviewed. They are not always consistent in their evaluation. A weight-of-evidence approach has been used, mirroring the process in many of the reports.

➤ 2015

World Health Organisation's International Agency for Research on Cancer (IARC) Monograph on glyphosate, featured news, <https://www.iarc.fr/featured-news/media-centre-iarc-news-glyphosate/>

'A Working Group of 17 experts from 11 countries met at the International Agency for Research on Cancer (IARC) on 3-10 March 2015 to review the available published scientific evidence and evaluate the carcinogenicity of five organophosphate insecticides and herbicides: diazinon, glyphosate, malathion, parathion, and tetrachlorvinphos.

In March 2015, IARC classified glyphosate as "probably carcinogenic to humans" (Group 2A).

This was based on "limited" evidence of cancer in humans (from real-world exposures that actually occurred) and "sufficient" evidence of cancer in experimental animals (from studies of "pure" glyphosate). IARC also concluded that there was "strong" evidence for genotoxicity, both for "pure" glyphosate and for glyphosate formulations. The IARC Monographs evaluation is based on the systematic assembly and review of all publicly available and pertinent studies, by independent experts, free from vested interests. It follows strict scientific criteria, and the classification system is recognized and used as a reference all around the world.

This is because IARC evaluations are based on independent scientific review and rigorous criteria and procedures. To reach these conclusions, IARC reviewed about 1000 studies. Some of the studies looked at people exposed through their jobs, such as farmers. Others were experimental studies on cancer and cancer related effects in experimental systems.'

➤ 2016

New Zealand Environmental Protection Agency, August 2016 Review of the Evidence Relating to Glyphosate and Carcinogenicity <https://www.epa.govt.nz/assets/Uploads/Documents/Everyday-Environment/Publications/f2f72882a7/EPA-glyphosate-review.pdf>

‘The overall conclusion is that – based on a weight of evidence approach, taking into account the quality and reliability of the available data – glyphosate is unlikely to be genotoxic or carcinogenic to humans and does not require classification under HSNO as a carcinogen or mutagen.’

‘Glyphosate has been detected in the blood and urine of agricultural workers, indicating absorption. Neimann et al, (2015) published a critical review and comparison of data obtained in a total of seven studies from Europe and the US. They concluded that no health concern was revealed because the resulting exposure estimates were several magnitudes lower than the acceptable daily intake (ADI) or the acceptable operator exposure level (AOEL).’

Australian Pesticides and Veterinary Medicines Authority, September 2016. Regulatory position: consideration of the evidence for a formal reconsideration of glyphosate ISBN 978-1-925390-49-0 www.apvma.gov.au

‘The APVMA agreed with the international assessments of the available epidemiological data that, while epidemiological data is of limited value for detecting carcinogenic potential of a pesticide, the weight-of-evidence does not provide convincing evidence for an association between glyphosate exposure in humans and any cancer type, as there was no consistent pattern of statistical associations that would suggest a causal relationship between glyphosate exposure and the development of cancer in adults or children (total or site-specific).

The APVMA agreed with the international assessments that the weight-of-evidence in experimental animals indicates that glyphosate does not pose a carcinogenic risk at realistic exposure levels, as no consistent dose-response relationship was evident in mice or rats and many of the reported tumours are common age-related tumours in rats and mice.

The APVMA agreed with the international assessments that glyphosate is not likely to be genotoxic, as well-designed in vitro tests consistently reported negative results. While some in vitro studies reported positive results for, these were generally observed following very high intraperitoneal doses and most likely a secondary effect of cytotoxicity.

Between 1996 and 2013, a total of four ‘possible’ or probable’ AERs relating to human safety (skin or eye irritation) were submitted to the AERP.

The APVMA is confident that the current safety and use directions included on approved labels for products containing glyphosate are sufficient to mitigate these known adverse effects.

6. PROPOSED REGULATORY POSITION

On evaluation of the scientific information, the Australian APVMA concludes that the scientific weight-of-evidence indicates that:

- Exposure to glyphosate does not pose a carcinogenic risk to humans
- There is no scientific basis for revising the APVMA's satisfaction that glyphosate or products containing glyphosate:
 - Would not be an undue hazard to the safety of people exposed to it during its handling or people using anything containing its residues
 - Would not be likely to have an effect that is harmful to human beings
 - Would not be likely to have an unintended effect that is harmful to animals, plants or things or to the environment
 - Would be effective according to criteria determined by the APVMA by legislative instrument, and
 - Would not unduly prejudice trade or commerce between Australia and places outside Australia.
- There are no scientific grounds for placing glyphosate and products containing glyphosate under
- Formal reconsideration
- The APVMA will continue to maintain a close focus on any new assessment reports or studies that indicate that any of the above conclusions may need revising.'

'Carcinogenicity studies in laboratory animals:

- European Food Safety Authority (EFSA) concluded that the weight-of-evidence is that there is no carcinogenic risk to humans related to the use of glyphosate.
- Joint Meeting of the Food and Agriculture Organization of the United Nations (FAO) Panel of Experts on Pesticide Residues in Food and the Environment and the World Health Organization (WHO) Core Assessment Group on Pesticide Residues (JMPR) concluded that glyphosate is not carcinogenic in rats but was unable to exclude the possibility that glyphosate is carcinogenic in mice at very high doses.
- The assessment conducted by EU European Chemicals Agency (ECHA) concluded that there was no evidence of carcinogenicity in mice or rats due to a lack of statistical significance in pair-wise comparisons, a lack of consistency across studies, that slightly increased tumour incidences were only evident at doses exceeding the maximum tolerated dose, the absence of early cellular changes or pre-neoplastic lesions and/or incidences that tumour incidences were in the range of normal biological variation.
- Health Canada concluded that there was no evidence that glyphosate was carcinogenic or genotoxic in rats but that there was some evidence for a marginal increase in the incidence of ovarian tumours in mice only at the highest tested dose—however, these results were considered to be of low concern for human health risk assessment.
- The assessment commissioned by the NZ EPA concluded that long- term carcinogenicity studies produced consistently negative results and that the IARC assessment attributed inappropriate weight to the studies included in its assessment, which did not demonstrate a dose-response relationship,

reported only minor positive results at the maximum dose tested, did not to consider relevant historical control data and excluded some studies that did not report positive associations between glyphosate exposure and carcinogenicity.

Genotoxicity studies:

- JMPR concluded that the overall weight-of-evidence is that glyphosate is unlikely to be genotoxic to humans at anticipated dietary exposures.
- EFSA, ECHA, Health Canada and the NZ EPA similarly concluded that the weight-of-evidence does not support the hypothesis that glyphosate is genotoxic. Again, these assessments concluded that the evidence presented by IARC as representative of strong evidence for genotoxicity and oxidative stress was primarily based on exposure scenarios not relevant to humans.

Epidemiological studies:

- ECHA concluded that the value of the human data for hazard classification purposes is questionable and limited because it is difficult to distinguish between the effects of the active constituent and co-formulants, as humans are never exposed to the active constituent alone, and humans are exposed to a many environmental chemicals, making it difficult to attribute health effects to one specific chemical.
- The JMPR, EFSA, ECHA and NZ EPA assessments concluded that while there was some evidence of a positive statistical association between glyphosate exposure and the risk of non-Hodgkin's lymphoma (NHL) in some retrospective case-control studies, the one large, high-quality prospective cohort study found no statistical association at any exposure level. The EFSA assessment further noted that it was not possible to differentiate between the effects of glyphosate and the co-formulants in the epidemiological data available. The ECHA assessment describes a number of papers that did not identify a risk between glyphosate exposure and various specific cancer types, including NHL, lymphomas in general or multiple myeloma. The ECHA concluded that a comprehensive review of epidemiological studies assessing the possible association between glyphosate exposure and cancer found no consistent pattern of positive associations that would suggest a causal relationship between glyphosate exposure and the development of cancer in adults or children. The ECHA further concluded that, while epidemiological data is of limited value for detecting the carcinogenic potential of a pesticide, the data do not provide convincing evidence for an association between glyphosate exposure in humans and any cancer type.
- The Health Canada assessment concluded that the majority of epidemiological data considered by IARC lacked adequate characterisation of glyphosate exposure and that as a result these studies were of limited use for supplementing the hazard assessment of glyphosate.'

US Environmental Protection Agency's (EPA) Office of Pesticide Programs September 12, 2016. Glyphosate Issue Paper: Evaluation of Carcinogenic Potential

'Since its registration in 1974, numerous human and environmental health analyses have been completed for glyphosate, which consider all anticipated exposure pathways. Glyphosate is currently undergoing Registration Review. As part of this process, the hazard and exposure of glyphosate are re-evaluated to determine its potential risk to human and environmental health using current practices and policies. The human carcinogenic potential of glyphosate has been evaluated by the agency several times. As part of the current evaluation for Registration Review, the agency has performed a comprehensive analysis of

available data from submitted guideline studies and the open literature. This includes epidemiological, animal carcinogenicity, and genotoxicity studies.

An extensive database exists for evaluating the carcinogenic potential of glyphosate, including 23 epidemiological studies, 15 animal carcinogenicity studies, and nearly 90 genotoxicity studies for the active ingredient glyphosate. These studies were evaluated for quality and results were analysed across studies within each line of evidence. The modified Bradford Hill criteria were then used to evaluate multiple lines of evidence using such concepts as strength, consistency, dose response, temporal concordance and biological plausibility. The available data at this time do not support a carcinogenic process for glyphosate.

Overall, animal carcinogenicity and genotoxicity studies were remarkably consistent and did not demonstrate a clear association between glyphosate exposure and outcomes of interest related to carcinogenic potential. In epidemiological studies, there was no evidence of an association between glyphosate exposure and numerous cancer outcomes; however, due to conflicting results and various limitations identified in studies investigating NHL, a conclusion regarding the association between glyphosate exposure and risk of NHL cannot be determined based on the available data.

Increases in tumour incidence were not considered treatment-related in any of the animal carcinogenicity studies. In 7 of these studies, no tumours were identified for detailed evaluation. In the remaining studies, tumour incidences were not increased at doses <500 mg/kg/day, except for the testicular tumours observed in a single study. Increased tumour incidences at or exceeding the limit dose (≥ 1000 mg/kg/day) are not considered relevant to human health.

Furthermore, data from epidemiological and animal carcinogenicity studies do not reliably demonstrate expected dose-response relationships. For cancer descriptors, the available data and weight-of-evidence clearly do not support the descriptors “carcinogenic to humans”, “likely to be carcinogenic to humans”, or “inadequate information to assess carcinogenic potential”.

For the “suggestive evidence of carcinogenic potential” descriptor, considerations could be looked at in isolation; however, following a thorough integrative weight-of-evidence evaluation of the available data, the database would not support this cancer descriptor. The strongest support is for “not likely to be carcinogenic to humans” at doses relevant to human health risk assessment.

7. Collaborative Research Plan for Glyphosate and Glyphosate Formulations

Some authorities believe that glyphosate formulations may be more toxic than glyphosate alone. Glyphosate has been studied in a multitude of studies and there are studies that have been conducted on numerous formulations that contain glyphosate; however, there are relatively few research projects that have attempted to directly compare glyphosate and the formulations in the same experimental design. Furthermore, there are even less instances of studies comparing toxicity across formulations.

The agency has been collaborating with the NTP Division of the National Institute of Environmental Health Sciences to develop a research plan intended to evaluate the role of glyphosate in product formulations and the differences in formulation toxicity. Four objectives were identified that laid out how research by NTP might contribute to these research questions:

- 1) Compare the toxicity of glyphosate vs. formulations, as well as compare formulations vs. formulations,
- 2) Provide publicly available toxicology data on cancer-related endpoints, 3) provide publicly available toxicology data on non-cancer endpoints, and 4) investigate the mechanisms of how glyphosate and formulations cause toxic effects.

Pesticide Action Network International (PAN) glyphosate monograph, October 2016

<http://pan-international.org/wp-content/uploads/Glyphosate-monograph.pdf>

‘Glyphosate-based herbicides can interfere with numerous mammalian organs and biochemical pathways, including inhibition of numerous enzymes, metabolic disturbances and oxidative stress leading to excessive membrane lipid peroxidation, and cell and tissue damage. Genotoxicity and endocrine disruption also lead to chronic health and developmental effects.’

‘Scientists have also found harmful effects on human cells at levels of glyphosate too low to have a herbicidal effect, some at levels similar to those found in food. These effects are amplified by the adjuvants in the Roundup formulation, which assist penetration of the cells by glyphosate. Several researchers have reported that glyphosate appears to accumulate in human cells. Glyphosate at low concentrations damages liver, kidney and skin cells; in the latter, it causes aging and potentially cancer. Its ability to penetrate skin increases 5-fold when skin is damaged.’

‘Studies have demonstrated that glyphosate and/ or Roundup cause genetic damage in human lymphocytes and liver cells; bovine lymphocytes; mouse bone marrow, liver, and kidney cells; fish gill cells and erythrocytes; caiman erythrocytes; tadpoles; sea urchin embryos; fruit flies; root-tip cells of onions; and in *Salmonella* bacteria. Other studies have shown that it causes oxidative stress, cell-cycle dysfunction, and disruption to RNA transcription, all of which can contribute to carcinogenicity. Several epidemiological studies have linked exposure to glyphosate with non-Hodgkin’s lymphoma, hairy cell leukaemia, multiple myeloma, and DNA damage.’

‘A number of studies have demonstrated that both glyphosate and the Roundup formulation disrupt oestrogen, androgen, and other steroidogenic pathways, and cause the growth of human breast cancer cells.’

‘Exposure to glyphosate-based herbicides, even at very low doses, may result in reproductive problems including miscarriages, pre-term deliveries, low birth weights, and birth defects. Laboratory studies have shown that very low levels of glyphosate, Roundup, POEA, and the metabolite AMPA all kill human umbilical, embryonic and placental cells. Roundup can kill testicular cells, reduce sperm numbers, increase abnormal sperm, retard skeletal development, and cause deformities in amphibian embryos.’

‘Glyphosate is assumed by regulators to have no neurological effects—the US EPA did not require neurotoxicity studies to be carried out for the registration of Roundup. However, a number of studies have shown that glyphosate can adversely affect nerve cells and affect neuronal development.’

‘Several studies indicate that glyphosate formulations may interfere with the immune system resulting in adverse respiratory effects including asthma, rheumatoid arthritis, and autoimmune skin and mucous membrane effects.’

‘Doctors in Argentina report vomiting, diarrhea, respiratory problems and skin rashes in association with aerial spraying of glyphosate on GM crops. Other acute symptoms of poisoning commonly reported from unintentional exposure include abdominal pain, gastrointestinal infections, itchy or burning skin, skin infections (particularly prevalent in children), blisters, burning or weeping eyes, blurred vision, conjunctivitis, headaches, fever, rapid heartbeat, palpitations, raised blood pressure, dizziness, chest pains, numbness, insomnia, depression, debilitation, difficulty in breathing, respiratory infections, dry cough, sore throat, and unpleasant taste in the mouth. Less common effects reported include balance disorder, reduced cognitive capacity, seizures, impaired vision, smell, hearing and taste, drop in blood pressure, twitches and tics, muscle paralysis, peripheral neuropathy, loss of gross and fine motor skills, excessive sweating, and severe fatigue.’

‘Glyphosate can cause metabolic and compositional changes, including altering the nutritional composition of foods, for example the protein and fatty acid content of soybeans. It can cause iron deficiency in soybeans, which is a concern for human health as human iron deficiency is widespread.’

‘Glyphosate has direct eco-toxicological effects and indirect effects. The later result from the unprecedented elimination of flora termed weeds. Direct and indirect effects have cascading impacts on the food chain and on biodiversity.’

‘In aquatic ecosystems, the direct eco-toxicological effects of glyphosate of greatest concern are those that occur at a subtle level, which can result in significant disruption of the ecosystem.’

➤ 2017

European Union European Chemical Agency (ECHA) Press Release Helsinki, 15 March 2017 <https://echa.europa.eu/-/glyphosate-not-classified-as-a-carcinogen-by-echa>

‘ECHA's Committee for Risk Assessment (RAC) agrees to maintain the current harmonised classification of glyphosate as a substance causing serious eye damage and being toxic to aquatic life with long-lasting effects. RAC concluded that the available scientific evidence did not meet the criteria to classify glyphosate as a carcinogen, as a mutagen or as toxic for reproduction.

Helsinki, 15 March 2017 – RAC assessed glyphosate’s hazardousness against the criteria in the Classification, Labelling and Packaging Regulation. They considered extensive scientific data in coming to their opinion.

The committee concluded that the scientific evidence available at the moment warrants the following classifications for glyphosate according to the CLP Regulation:

- Eye Damage 1; H318 (Causes serious eye damage)
- Aquatic Chronic 2; H411 (Toxic to aquatic life with long lasting effects)

RAC concluded that the available scientific evidence did not meet the criteria in the CLP Regulation to classify glyphosate for specific target organ toxicity, or as a carcinogen, as a mutagen or for reproductive toxicity.’

Current status of glyphosate in EU, https://ec.europa.eu/food/plant/pesticides/glyphosate_en

‘On 12 December 2017, the Commission renewed the approval of glyphosate for 5 years, following support by a qualified majority of Member States in an Appeal Committee held on 27 November 2017. Therefore, glyphosate can be used as an active substance in Plant Protection Products (PPPs), until 15 December 2022, subject to each PPP being authorised by national authorities following an evaluation of their safety.’

US EPA The Revised Glyphosate Issue Paper of December 12, 2017 <https://www.epa.gov/ingredients-used-pesticide-products/draft-human-health-and-ecological-risk-assessments-glyphosate>

‘For cancer descriptors, the available data and weight-of-evidence clearly do not support the descriptors “carcinogenic to humans”, “likely carcinogenic to humans”, or “inadequate information to assess carcinogenic potential”. For the “suggestive evidence of carcinogenic potential” descriptor, considerations could be looked at in isolation; however, following a thorough integrative weight-of-evidence evaluation of the available data, the database would not support this descriptor. The strongest support is for “not likely to be carcinogenic to humans.”’

➤ 2019

Exposure to glyphosate-based herbicides and risk for non-Hodgkin lymphoma: A meta-analysis and supporting evidence. Zhang et al 2019 <https://doi.org/10.1016/j.mrrev.2019.02.001>

‘meta-analysis of human epidemiological studies suggests a compelling link between exposures to GBHs and increased risk for non-Hodgkin lymphom’

People with high exposures to the popular pesticides have a 41% increased risk of developing a type of cancer called non-Hodgkin lymphoma.

Current status of glyphosate in EU, https://ec.europa.eu/food/plant/pesticides/glyphosate_en

‘The EU pesticides legislation requires that the approval of all active substances must be periodically reviewed, starting with a scientific assessment by a rapporteur Member State, which is followed by a peer-review process overseen by the European Food Safety Authority (EFSA).

On 15 April 2019, Member States in the Standing Committee on Plants, Animals, Food and Feed endorsed the Commission’s proposal to designate four Member States as joint rapporteurs for the next assessment of glyphosate. This Assessment Group on Glyphosate (AGG) comprises France, Hungary, the Netherlands and Sweden.’

US EPA Letter to registrants about glyphosate

https://www.epa.gov/sites/production/files/2019-08/documents/glyphosate_registrant_letter_-_8-7-19_-_signed.pdf

Ernslaw One ESRA for Glyphosate Version 1.1 April 2020

'We are writing to you concerning label and labelling requirements for products that contain glyphosate.

On July 7, California listed glyphosate as a substance under Proposition 65 based on the International Agency for Research on Cancer's (IARC's) classification of the pesticide as "probably carcinogenic to humans." EPA disagrees with the IARC's assessment of glyphosate. EPA scientists have performed an independent evaluation of available data since the IARC classification to re-examine the carcinogenic potential of glyphosate and concluded that glyphosate is "not likely to be carcinogenic to humans." EPA considered a more extensive dataset than IARC, including studies submitted to support registration of glyphosate and studies identified by EPA in the open literature as part of a systematic review.'

'Given EPA's determination that glyphosate is "not likely to be carcinogenic to humans." EPA considers Proposition 65 warning language based on the chemical glyphosate to constitute a false and misleading statement.'

➤ 2020

The US Environmental Protection Agency used the most current science policies and risk assessment methodologies to prepare a risk assessment in support of the registration review of glyphosate. The agency did not identify potential risks of concern for fish, aquatic invertebrates, or aquatic phase amphibians. Low or limited potential risks of concern were identified for mammals and birds. Consistent with its mode of action as an herbicide, potential risks to non-target terrestrial and aquatic plants were primarily from spray drift and the resulting distances from the edge of the field to below toxicity threshold were heavily dependent on the application rate used.

The epidemiological literature was reviewed but most studies were hypothesis-generating in nature. The [US] EPA found there was insufficient evidence to conclude that glyphosate plays a role in any human diseases. Since the last EPA review of the epidemiological literature, two studies regarding the association between glyphosate exposure and non-Hodgkin's Lymphoma (NHL) were identified for detailed review by the agency; however, these studies did not impact the agency's assessment. For more information, refer to Glyphosate: Response to Comments on the Proposed Interim Decision Regarding the Human Health Risk Assessment

The USA EPA is requiring label changes to reduce off-target spray drift and establish a baseline level of protection against spray drift that is consistent across all products containing glyphosate.

<https://www.epa.gov/sites/production/files/2020-01/documents/glyphosate-interim-reg-review-decision-case-num-0178.pdf>

Appendix 2: Glyphosate and Soil and Water - Summary of Reviews

The information within the Material Safety Data Sheet Appendix should be considered in conjunction with the information within this appendix.

Soil

Carol A. Rolando et al. June 2017. *The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests*

The rapid uptake in plants and strong sorption to soils, clay minerals or other organic materials essentially immobilize glyphosate and minimise off-site movement unless there are major storm events within a few hours of treatment or where surface water flows are so great they are actually mobilizing soil particles with adsorbed glyphosate. However, upon release into most natural environments all glyphosates salts readily dissociate to yield the glyphosate free acid molecule.

Most forest soils are characterised by the presence of litter layers with high organic carbon content and as a result provide an effective sink for glyphosate residues. Glyphosate acid itself is zwitterionic, carrying both a positive and negative charge under typical environmental pH conditions but in different proportions depending upon the exact pH [27,58,59]. It is the zwitterionic character of the glyphosate molecule which is responsible for its tendency to sorb strongly to organic matrices or clay minerals. On reaching the soil environment, either directly or indirectly, the breakdown of glyphosate in forest floor litter and soils is generally rapid (litter: DT50 8 to 19 days; soil: DT50 5 to 40 days) [52,54,57], with microbial degradation considered the primary degradation pathway [52,60,61], although there may be some limitations on the ability of microorganisms to completely mineralise glyphosate and its primary metabolite, AMPA [62].

The half-life of glyphosate (DT50) is commonly used as a measure of degradation processes and persistence in the environment. The foliar DT50 for glyphosate ranged from less than one day to 14 days where application rates ranged from 1.98 to 3.3 kg a.i. ha⁻¹

‘Studies have generally reported minimal impacts from glyphosate applied under typical application rates in forests, on litter decomposition, soil microbial communities and soil microbial processes.’

Pesticide Action Network International (PAN) glyphosate monograph, October 2016

‘As with the aquatic environment, it is the subtle effects causing disruption of the ecosystem that are of greatest concern, particularly effects on the agroecosystem. Glyphosate is toxic to some but not all soil microorganisms, altering microbial community dynamics in ways that are harmful to plants and to ecological balance. It increases microorganisms capable of metabolising the chemical. It can reduce some beneficial organisms such as saprophytic fungi that decompose dead plant material and are important for soil fertility. Numerous studies have shown that glyphosate stimulates the growth of a number of fungal pathogens that cause diseases in many crops.’

‘It is less persistent in warmer climates, with a half-life between 4 and 180 days. It is bound onto soil particles, and this was once thought to mean that glyphosate is not biologically active within soil, nor will it leach to groundwater. However, it is now known that it can easily become unbound again, be taken up by plants or leach out, indicating a greater risk of groundwater contamination.’

Water – ground, surface, water supplies

Groundwater and water supplies

In 2018 ESR in conjunction with Regional Councils screened 135 wells for glyphosate and their principal metabolites in groundwater. There was only one detection of glyphosate at a concentration of 2.1 $\mu\text{g/L}$. (Close & Humphries 2019). ESR noted that well had poor well-head protection and the contamination likely came from containers that were stored near the well. No MAV for glyphosate in drinking water has been set in New Zealand. New Zealand follows WHO guidelines when setting its MAVs but there is currently no WHO guideline; however, WHO does have a Health Based Value for glyphosate of 900 $\mu\text{g/L}$ (WHO 2017). The detected level of 2.1 $\mu\text{g/L}$ is far below this value.

Rolando C. et al. June 2017. *The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests*

‘In New Zealand, although herbicides are the most commonly detected pesticide in national surveys of groundwater, no glyphosate has yet been detected [130] despite the relatively high dependence on this active ingredient in agriculture and across primary industry [37].’

‘In forest soils, glyphosate is rarely detected below the upper 15 cm level of soils [51,52,57,60,61], indicating that it is very unlikely to percolate down through forest soils and into groundwater. Given that in forestry scenarios glyphosate use is much less frequent than that in agricultural situations the risk to humans from water consumption is low.’

Surface water

Rolando C et al. June 2017. *The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests*

‘In forested catchments, the exposure of humans (and terrestrial fauna) to high levels of glyphosate in forest streams through consumption of contaminated surface waters is unlikely given the low risk of movement of glyphosate into stream water sources following application in planted forests, coupled with rapid degradation and dilution downstream, as described in Section 3. Moreover, there is no evidence that the use of glyphosate in forested catchments has resulted in levels of glyphosate in water bodies likely to exceed human health and drinking water standards.’

‘The majority of glyphosate-based herbicides, applied either aerially or manually in managed forests, are intercepted by the competing vegetation canopy [51–54]. Once on the foliage, glyphosate is rapidly absorbed and translocated within the plant [53,55]. The time for glyphosate rain fastness (where the glyphosate has either dried or been sufficiently absorbed to maintain its effectiveness) varies from several hours to several days depending on the characteristics of the targeted weed species and the specific formulation applied [27,53]. Until rain fastness has been achieved, glyphosate is vulnerable to wash-off from heavy dew and rainfall events.’

‘On the day of herbicide application, glyphosate can potentially enter freshwater environments within forests either from direct spray or spray-drift [69] or possibly accidental spillage [63]. Some of the highest concentrations of glyphosate in water bodies are therefore detected on the day of herbicide application, although these are typically below thresholds of significant biological impacts in terms of both exposure

magnitude and duration. The highest concentrations detected have been in association with either operational [52] or experimental over-spraying of waterbodies [56,70] (Table 3). During the immediate post-application period, mobilisation of glyphosate residues from foliage, litter or soil via wash-off from heavy dew, rainfall events, and mobilisation of in-channel or riparian herbicide residues during high flow events, can provide additional sources of glyphosate to aquatic environments [51,56,71]. As discussed, transfer of terrestrial sources of glyphosate to aquatic environments via leaching, run-off or surface erosion, are unlikely to be major input pathways in forested environments and these processes are considered low risk.'

'Regardless of input pathways, once in the aquatic environment, most forest studies recorded a rapid decline in glyphosate concentrations in waterbodies following herbicide application or rainfall events. Field studies show DT50 for glyphosate of <5 days (Table 3). Glyphosate residues in streams and lentic bodies such as ponds and wetlands typically dissipated to below detection limits within 15 days of application [51,52,56,70,76]. These short time frames indicate a rapid breakdown or reduction of glyphosate in the water column, either by adsorption into benthic and suspended sediments, through microbial breakdown within the freshwater ecosystem.'

Sediment

Rolando C. et al. June 2017. *The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests*

The high adsorption capacity of sediment for glyphosate has frequently resulted in higher peak concentrations in sediments compared with water (Table 3), that persisted for longer periods of time, even when the active ingredient was present in only small quantities in the water column (Table 3). It is likely that this process is a primary pathway for removal of glyphosate from the water column in forested freshwater environments.

Appendix 3: Glyphosate and Aquatic and Terrestrial Biota - Summary of Reviews

The information within the Material Safety Data Sheet Appendix should be considered in conjunction with the information within this appendix.

Aquatic biota

Carol A. Rolando et al. June 2017. *The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests*

‘Field studies on the aquatic fate of glyphosate in managed forests (Table 3), indicate that the concentrations and duration of glyphosate typically measured, with the exception of direct over-spraying of wetlands [70], were well below the standard toxicity endpoints for fish and other aquatic organisms (Table 2) [71,88,89], often by orders of magnitude. In forest operational scenarios, the aquatic systems most likely to be over-sprayed are small shallow wetlands and low-order streams that are difficult to detect or avoid during aerial spray applications.’

Pesticide Action Network International (PAN) glyphosate monograph, October 2016

‘Glyphosate is water soluble, and is increasingly found in the environment at levels that have caused significant effects on species that underpin the entire aquatic food chain. Glyphosate and/or Roundup can alter the composition of natural aquatic communities, potentially tipping the ecological balance and giving rise to harmful algal blooms. It can have profound impacts on microorganisms, plankton, algae and amphibia at low concentrations: one study showed a 70% reduction in tadpole species and a 40% increase in algae. Insects, crustaceans, molluscs, reptiles, and fish can also be affected, with vulnerability within each group varying dramatically between species. Effects include reproductive abnormalities, developmental abnormalities and malformations, DNA damage, immune effects, oxidative stress, modified enzyme activity, decreased capacity to cope with stress and maintain homeostasis, altered behaviour, and impaired olfaction that can threaten their survival.

‘Amphibians may be particularly susceptible to the effects of glyphosate herbicides because their preferred breeding sites are often shallow ephemeral pools that, by virtue of the small amount of water, can contain high concentrations of herbicides (Mann et al 2009). Studies show them to be particularly susceptible to formulations containing POEA. Sublethal effects include metabolic disturbance, oxidative stress, DNA damage, endocrine disruption, malformations, and behavioural changes that make them more vulnerable to predators.’

‘Adverse impacts on fish caused by glyphosate and more especially formulations that contain POEA include acute poisoning; structural effects on gills, kidney, liver and gut; oxidative stress; genotoxicity; metabolic, immune, endocrine, neurotoxic and reproductive effects; and behavioural outcomes that increase vulnerability to other environmental stressors including predators.’

When the New Zealand freshwater fish *Galaxias anomalus* was simultaneously exposed to glyphosate at “environmentally relevant concentrations” and a trematode parasite, *Telogaster opisthorchis*, juveniles developed spinal malformations not seen with either the parasite or the glyphosate alone (Kelly et al 2010).

Terrestrial, non-human

Carol A. Rolando et al. June 2017. *The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests*

Terrestrial fauna residing in forested areas treated with glyphosate are potentially at risk of exposure to glyphosate via direct spray, spray drift or wash-off following rainfall events, and uptake via inhalation and absorption, (Figure 1), although there is little information available on this [80]. Secondary exposure is also possible through the ingestion of flora and fauna food sources containing glyphosate residues [52].'

Table 2. Generic human toxicology and environmental persistence data for glyphosate and isopropylammonium salt [5,23,38,40,64,65].

Parameter	Unit	Glyphosate Isopropylammonium	EFSA 2015 Recommendations
Kow (log P)		< -5.4 (20 °C)	
Solubility in water	g/L	1050 (25 °C, pH 4.3)	
Koc		1424	
pKa		5.77	
ARfD	mg/kg bw		0.5
NOAEL (2 years) rats	mg/kg bw	31	
AOEL	mg/kg bw		0.1
Drinking water standard #	µg L ⁻¹	Australia, 1000; USA, 700	
Acute Oral LD ₅₀ (rats)	mg/kg bw	>5000	
Inhalation LC ₅₀ (4 h) (rats)	mg/L air	1.3	
Acceptable daily intake (ADI)	mg/kg bw per day	1 (2004)	0.5
WHO Toxicity class		2B	
WHO Hazard class		III (slightly hazardous)	
LC ₅₀ Trout (96 h)	mg/L	>1000	
LC ₅₀ <i>Daphnia</i> (48 h)	mg/L	930	
EC ₅₀ Algae (72 h)	mg/L	72.9	
LC ₅₀ Earthworm (14 day)	mg/kg soil	>5000	
LD ₅₀ Bee	µg/bee	>100	
DT ₅₀ soil	Days	1–130	
DT ₅₀ water	Days	<190	
Major metabolite in soil and water		metabolised to aminomethylphosphonic acid (AMPA)	

EFSA—European Food Safety Authority; ARfD—Acute reference dose; NOAEL—No observed adverse effect level; AOEL—Acceptable operator exposure level; ADI—The acceptable daily intake value is the maximum quantity of chemical that humans can absorb in a day for their entire lifespan without showing any signs of illness, bw = body weight; DT₅₀—The rate of degradation of pesticides in soils is often expressed as the time to 50% dissipation (DT₅₀) in years, months or days; K_{ow}—The octanol-water partition coefficient is the ratio of the concentration of a chemical in octanol and in water at equilibrium; pKa—acid dissociation constant; K_{oc}—The soil organic carbon (OC) affinity coefficient represents the soil distribution coefficient (K_d) normalised for soil organic carbon content; LD₅₀—is the dose that kills half (50%) of the animals tested (LD = "lethal dose"); LC₅₀—is the concentration in water that kills half (50%) of the animals tested (LC = "lethal concentration") and EC₅₀ is the "Effective Concentration", that is the concentration which has some deleterious effect, other than lethality, on 50% of the animals tested. # Neither the World Health Organisation, nor South Africa and New Zealand have established a drinking water standard for glyphosate and AMPA because of its occurrence in drinking-water at concentrations well below those of health concern [66–68].

Pesticide Action Network International (PAN) glyphosate monograph, October 2016

‘Amphibians are particularly vulnerable.’

‘Glyphosate has adverse effects on some earthworms; and a number of beneficial insects useful in biological control, particularly predatory mites, carabid beetles, ladybugs, and green lacewings. It can also adversely affect other insects that play an important part in ecological balance such as springtails, wood louse, and field spiders. Glyphosate, at levels commonly found in agricultural settings, impairs honeybees’ cognitive capacities affecting their navigation with potential long-term negative consequences for colony foraging success.’

‘Glyphosate use may result in significant population losses of a number of terrestrial species through habitat and food supply destruction. There have been reports of numerous deaths of livestock and domestic animals as a result of the aerial spraying of glyphosate in Colombia.’

‘In a small study in New Zealand, the common skink *Oligosoma polychroma* was sprayed once with glyphosate, glyphosate + POEA, or water. Their thermoregulatory behaviour, sprint speed, and weight were then monitored for 6 weeks. The skinks sprayed with glyphosate + POEA selected warmer microclimates and had slower sprint speeds than skinks that had been sprayed with glyphosate only or water. Sprint speed is an important predictor of lizard health and survival; and selecting hotter microclimates can lead to dehydration and greater predation rates, as skinks are more likely to be basking in exposed areas (Carpenter 2013).’

Bioaccumulation

Carol A. Rolando et al. June 2017. *The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests*

The risk of bioaccumulation through secondary exposure to glyphosate is known to be low, based on its low octanol-water partition co-efficient (logP Kow) (Table 2), well below the octanol-water partition co-efficient of 5.0 or greater suggested by Mackay and Fraser [81] as a threshold for the onset of bioaccumulation. In addition, studies have documented facile depuration via urine and faeces and a lack of significant residues accumulating in animal tissues [52,54]. In both these studies, glyphosate residues in the viscera, stomach contents and tissue samples of a range of small and large mammals were at or below concentrations found in ground cover and litter residues, indicating that glyphosate was not bioaccumulating in higher trophic levels.

Pesticide Action Network International (PAN) glyphosate monograph, October 2016

‘EFSA gives a bioconcentration factor (BCF) of 1.2 (+ 0.61). However, bioaccumulation of glyphosate may be greater than predicted). The BCF for glyphosate is increased in the presence of POEA in the aquatic environment. This may be because POEA, which is known to enhance glyphosate transport into plant

Appendix 4:

Chemical Pesticides use in Forest Stewardship Council Certified Forests

(Public Summary for web site)

FSCtm and Pesticide Use

The Forest Stewardship Council's (FSCtm) Pesticides Policy regulates the use of chemical pesticides in FSC certified forests¹⁵.

FSC's long-term aim is to eliminate the use of chemical pesticides while the short-term objectives are to:

- Promote best practices to minimise risks to human health and the environment
- Reduce the overall volume and number of chemical pesticides in use
- Eliminate the use of the most hazardous chemical pesticides.

NZ's FSC certified forest managers, including Ernslaw One, take an integrated management approach to pests and weeds, but there are currently no clear or easy solutions to the elimination of certain chemical pesticides in plantation forests. In fact, eliminating the use of a few key chemical pesticides might create perverse outcomes. For example, weed control undertaken by aerial spraying with glyphosate and metsulfuron has reduced or eliminated higher impact land preparation techniques such as burning; a return to burning would likely lead to higher and longer-term impacts upon soils, nutrients, biodiversity impacts and stream quality/soil stability. The same holds for the use of vertebrate toxins used to control possum populations.

The FSC has recognised the challenges of finding alternatives and the pesticides policy states:

- *'1.2 FSC recognizes that in certain circumstances, and after having considered other available pest management strategies and practices, the use of chemical pesticides may be the only feasible way of controlling a pest, weed or disease.'*
- *'4.2 In certain instances, a more hazardous alternative may present lower social and environmental risks than a less hazardous option.P.20 pesticides policy'.*

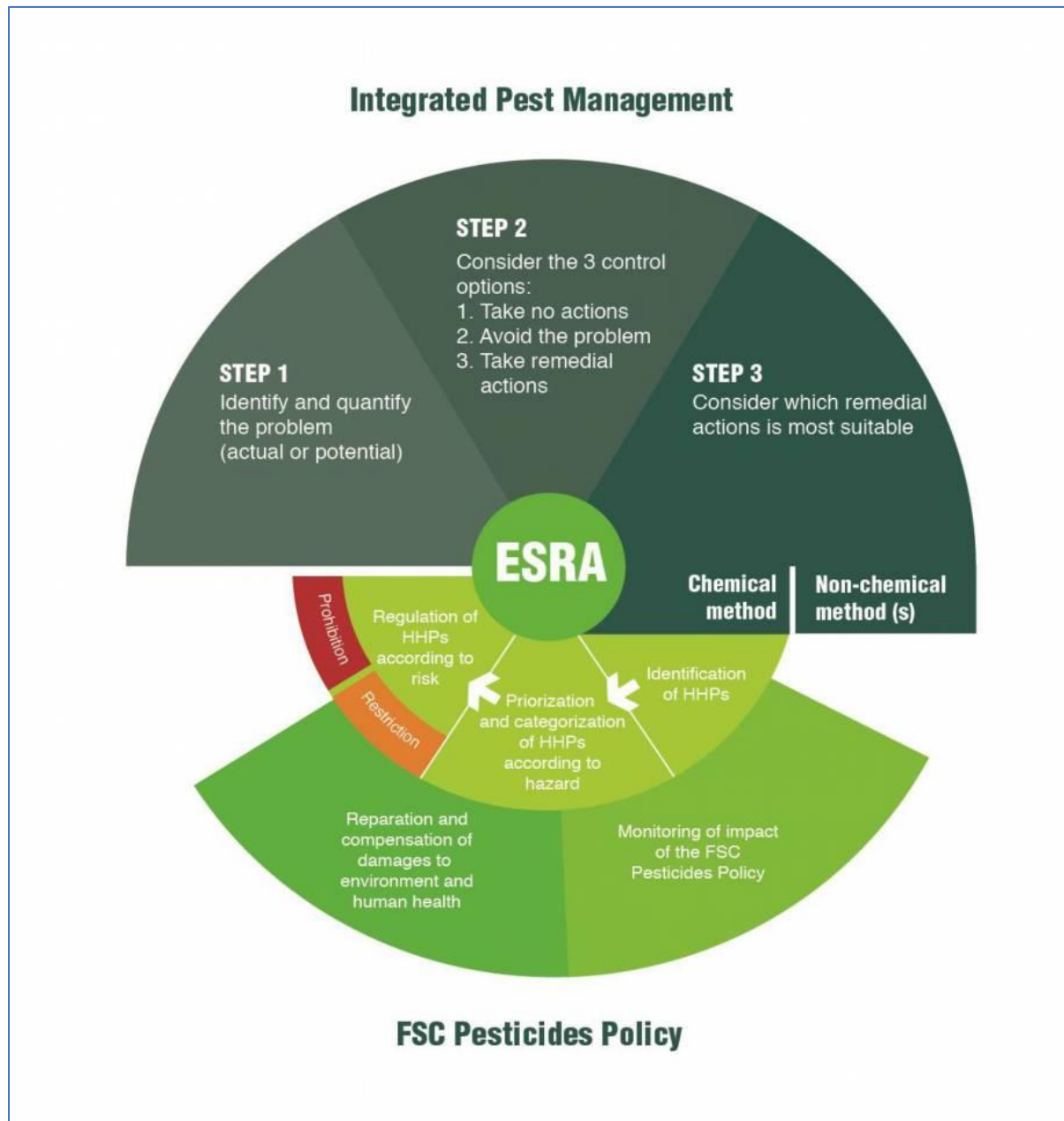
FSC's 2019 Pesticide Policy – A Change in Approach

The FSC in August 2019 introduced a new pesticide policy. It incorporates a risk-based approach that considers not only the hazard of the active ingredient but also how the chemical pesticide is used. The new approach requires Ernslaw and all other FSC certified companies to complete an **Environmental and Social Risk Assessment (ESRA)**. This is explained fully in the pesticide policy and the annex.

Risk-based assessment is a significant shift from the previous pesticide policy that followed a hazard approach which identified chemical pesticides with high toxicity and prohibited their use unless the FSC Board of Directors granted a temporary derogation for their use.

¹⁵ <https://fsc.org/en/media/5446> or <https://nz.fsc.org/en-nz/policies/forest-management-02/pesticide-use>

If any FSC certified forest manager wants to use a pesticide designated by FSC as **Highly Hazardous** (a **HHP**) and that forest manager does not hold a derogation from FSC for its use, or the derogation is no longer valid, then the forest manager needs to complete an Environmental and Social Risk assessment (ESRA).



What is an ESRA?

FSC describes an ESRA as ‘a process to predict, assess and review the likely or actual environmental and social effects of a well-defined action, evaluate alternatives, and design appropriate mitigation,

management and monitoring measures. In the context of the FSC Pesticide Policy, it relates to chemical pesticide use.'

An ESRA contains these main steps:

- Identify the lowest risk option to control a pest, weed or disease, the conditions for its use and the generic mitigation and monitoring measures to minimise the risks
- Consider the approved list of hazards, exposure elements and exposure variables
- Select the option that demonstrates the least social and environmental damages, more effectiveness and equal or greater social and environmental benefits
- Before applying any chemical pesticide, incorporate the results of the ESRA to site operational plans, to identify site-specific risks
- Use of HHP according to approved methods
- Make the ESRA and incorporation to the operational plans available to affected stakeholders upon request.

FSC's transition from Derogations to Environmental and Social Risk Assessments (ESRAs)

Many commonly used forestry pesticides currently have derogations. The table below shows the pesticides requiring derogations and their expiry date. The new policy means that no new derogations applications will be processed. Existing approved derogations and their conditions will remain valid until their expiry date or until national HHP indicators become effective and replace the derogations.

If Ernslaw need to use pesticide designated by FSC as (1) a prohibited HHPs (in an emergency or by governmental order), (2) a highly restricted HHP, or (3) a restricted HHP and there isn't a valid derogation in place for its use, Ernslaw will need to conduct an environmental and social risk assessment (ESRA).

What are FSC's Highly Hazardous Pesticides?

FSC recently revised its list of Highly Hazardous Pesticides (HHP).

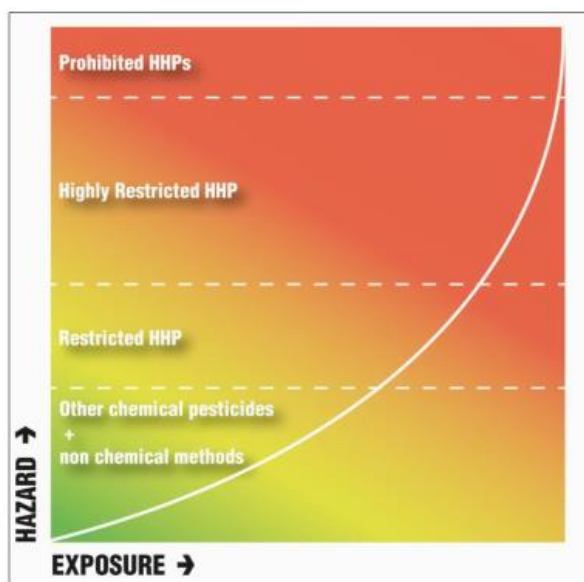
Refer: <https://fsc.org/en/document-center/documents/375>.

FSC identifies Highly Hazardous Pesticides using internationally recognised hazard groups and criteria, and their associated indicators and thresholds. FSC distinguishes between three categories of risk:

- Prohibited HHPs (**Tier 1**)
- Highly restricted HHPs (**Tier 2**).
- FSC restricted HHPs (**Tier 3**).

Prohibited HHPs are listed or recommended for listing under Annex A (elimination) of the Stockholm Convention on Persistent Organic Pollutants (POPs), or Annex III of the Rotterdam Convention on the Prior Informed Consent procedure, or listed under the Montreal Protocol on Substances that Deplete the Ozone Layer, which is given effect to in NZ by the Ozone Layer Protection Act 1996¹⁶.

Diagram from FSC Pesticide policy (Figure 3). Risk is expressed as a function of toxicity (hazard) and exposure, and as the risk increases, FSC Certified forest managers must intensify the activities undertaken to mitigate that risk.



Almost all the HHPs designated by FSC as “Prohibited” (Tier 1) are acutely toxic and can induce cancer, or contain dioxins, or contain heavy metals. After the one-year transition to the 2019 pesticide policy, FSC Prohibited HHPs shall not be used outside emergencies or governmental orders.

Highly Restricted HHPs and Restricted HHPs are categorised based on the hazards of acute toxicity, chronic toxicity and environmental toxicity and their toxic characteristics for humans and the environment. Highly Restricted HHP include any pesticide meeting two or three out of three hazard groups, for example, acute toxicity and chronic toxicity and environmental toxicity, or acute toxicity and chronic toxicity. The FSC list of restricted HHPs includes any chemical pesticide belonging to one out of the three hazard groups, so acute toxicity or chronic toxicity or environmental toxicity.

Ernslaw uses the following Highly Hazardous Pesticides under derogation or permission from FSC¹⁷

Tier 1. Prohibited Pesticides in use	Tier 2. Highly Restricted Pesticides in use	Tier 3. Restricted Pesticides in use
none	none	*Glyphosate and its salts (this ESRA)
		*Copper oxychloride
		*Cuprous oxide
		Cholecalciferol (a vertebrate toxin)
		Picloram (recommended by DoC for woody weeds)
		Sodium cyanide (Ernslaw’s derogation expires 20 July 2021)
		Sodium fluoroacetate (1080) (Ernslaw’s derogation expires 20 July 2021)

* = newly added to the FSC list (valid Feb 2020). Note that FSC has removed the herbicides hexazinone and terbuthylazine have from their HHP list.

¹⁶ www.legislation.govt.nz/act/public/1996/0040/latest/DLM391469.html

¹⁷ Our Derogation documents are stored in our national drive under Environment\FSC\ Pesticide derogations

How Do We Mitigate the Risks?

Describing the ways to mitigate the risks is an essential step in an ESRA. It is not only FSC that requires this but the law too. Forestry companies have detailed processes and risks are assessed right through the planning, doing, and monitoring of the job:

- Develop an operational plan*
- Meet legal requirements
- Select formula and rates*
- Meet training, competencies, and job responsibilities requirements*
- Notify neighbours (if treatment area adjoins property boundary or could impact*) – use community newspapers or Facebook pages
- Operational briefing and sign-off plan
- Health and safety, and hazard identification*
- Clear operational areas of non-authorized people
- Transport and storage
- Mixing and loading sites
- Calibration of equipment
- Weather and climatic conditions*
- Apply pesticide only to the treatment area*
- Prevent leaching and spray drift *
- Social responsibility and care during operations (neighbours and community)
- Contain spills*
- Keep operational records*
- Post op monitoring
- Improve operational effectiveness*

* are those required by FSC's ESRA

Identifying Alternatives to Pesticides - the Integrated Pest Management 'toolbox'

There are many alternatives to the application of pesticides. These methods are part of the Integrated Pest Management (IPM) 'toolbox'. These include burning, mechanical land preparation, hand weeding, mechanical releasing, grazing, oversowing, weed mats, and biological control. However, in most cases, alternative options have proven not as practical, safe or cost-effective.

Companies individually and collectively have been supporting pesticide research into alternative methods as part of their commitment to FSC for nearly 20 years. In conjunction with this, companies have been following the '**remove, replace or reduce**' (3 R's) philosophy at the heart of the FSC's pesticide policy's 4.12 (1).

Ernslaw, an FSC certified forest manager, challenges itself with following questions, in accord with FSC's guide to integrated pest, disease and weed management in its operations on its plantations¹⁸.

Weed management options range from:

- Ignoring or avoiding the problem
- Take no action (but neither is not consistent with good forest management)

Through to:

- Using biological control options (including funding research thereon)
- Improving crop species selection to reduce the impact of the weeds
- Changing silviculture management
- Using environmental manipulation, e.g. mechanical methods
- Using selective herbicides
- Using broad-spectrum herbicides
- Applying a selective area spray application
- Changing spray timing to reduce application rates

NZ is an urban society, with over 90% of people living in an urban setting. Labour availability is a massive issue for forestry in NZ. While plantation forests are part of the rural landscape, it has become increasingly difficult to get people to do manual forest operational tasks like weed control. At the time of writing, unemployment was at historically low levels, so there are fewer incentives for people to move to rural areas to undertake harder physical work in forestry. Silviculture, like much of the primary sector, is becoming reliant on overseas workers.

A compounding issue is that the regulatory approval for the introduction and use of new pesticides is very slow and expensive. The NZ plantation forest industry is a tiny consumer of pesticides both in global terms and per hectare per year. The slow process of developing alternatives and the regulatory conditions reduce the likelihood that new and more acceptable pesticides will be available for the forest industry in the future.

Until non-herbicide methods of weed control become available which are reliable, operationally effective, economically viable and environmentally sound, there will still be a dependence on pesticide weed control. Currently, without pesticides like glyphosate, much of NZ's plantation forestry would not be feasible, relinquishing all the positive benefits of this land use. The alternative economic land use is to re-convert plantations back to agriculture, which would have the perverse effect of significantly increasing both pesticides loading and nutrient leaching to land and water.

The Detail: What Hazards, Exposure Elements and Exposure Variables Need Considering?

Annex 2 in FSC's Pesticide Policy details the minimum list of hazards, elements and variables to consider in the assessment of environmental and social risks.

The risks of the following hazards need identifying and assessing:

- Acute toxicity

¹⁸ <https://fsc.org/en/document-centre/documents/resource/383>

- Toxic by contact or ingestion
- Toxic by inhalation
- Chronic toxicity
 - Carcinogenicity
 - Mutagenicity to mammals
 - Developmental and reproductive toxicity
 - Endocrine disruption
- Environmental toxicity
 - Acute toxicity to aquatic organisms
 - Persistence in soil and water
 - Biomagnification and bioaccumulation.

Exposure elements are types of values that may be negatively affected by chemical pesticide use. The following environmental and social values shall be considered:

- Soil (erosion, degradation, biota, carbon storage)
- Water (groundwater, surface waters, water supplies)
- Atmosphere (air quality, greenhouse gasses)
- Non-target species (vegetation, wildlife, bees and other pollinators, pets)
- Non-timber forest products (as FSC-STD-01-001 V5-2 FSC Principles and Criteria, criterion 5.1)
- High Conservation Values (particularly HCV 1-4)
- Landscape (aesthetics, cumulative impacts)
- Ecosystem services (water, soil, carbon sequestration, tourism).
- High Conservation Values (especially HCV 5-6)
- Health (fertility, reproductive health, respiratory health, dermatologic, neurological and gastrointestinal problems, cancer and hormonal imbalance)
- Welfare
- Food and water
- Social infrastructure; (schools and hospitals, recreational infrastructure adjacent to the management unit)
- Adjacent agricultural activity (including use of the same herbicides & pesticides) and livestock
- Rights (legal and customary).

Local exposure variables will affect the level of exposure. To reduce the risk of chemical pesticide use, the following variables shall be considered:

- Formulation (type and components).
- Mixture of active ingredients (composition and mixing process)
- Concentration of the active ingredient(s)
- Dose of the active ingredient(s)
- Frequency and interval of application
- Scale of treatment area
- Method of application (e.g., spot, foliar, spray, aerial, broadcast)
 - Application system and equipment (e.g., knapsack sprayer, helicopter, drone, plane)
 - Number of previous applications
 - Metabolites of the active ingredient

- Capacity and skills of workers (license to handle pesticides, training, ability to read and understand labels and instructions)
- Personal protective equipment
- Emergency related equipment (e.g., first aid, spill kits)
- Site conditions (e.g., soil type, topography of the area)
- Predicted weather and climatic conditions (e.g., wind speed and direction, temperature, humidity)
- Potential for Spray drift
- Waste management systems
- Refer neighbours to our web site for information about pesticide application (e.g., risks associated with pesticide use, re-entry period after application).

At the time of writing, Ernslaw had completed one ESRA, for Glyphosate (an agrichemical commonly known as Roundup), with other ESRAs in preparation for other pesticides deemed by FSC as Highly Hazardous. Our Glyphosate ESRA is available from the manager of Ernslaw's Environmental Monitoring and Performance Team, along with a summary of annual use.

Ernslaw One holds two FSC® forest management certificates:

- Our North Island estate holds FSC® certificate number C010424.
- Our South Island estate holds FSC® certificate number C015328.

Appendix 5: Review: The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests. Ronaldo et al (2017).



Review

The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests

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Abstract: Glyphosate-based herbicides are the dominant products used internationally for control of vegetation in planted forests. Few international, scientific syntheses on glyphosate, specific to its use in planted forests, are publically available. We provide an international overview of the current use of glyphosate-based herbicides in planted forests and the associated risks. Glyphosate is used infrequently in planted forests and at rates not exceeding 4 kg ha⁻¹. It is used within legal label recommendations and applied by trained applicators. While the highest risk of human exposure to glyphosate is during manual operational application, when applied according to label recommendations the risk of exposure to levels that exceed accepted toxicity standards is low. A review of the literature on the direct and indirect risks of operationally applied glyphosate-based herbicides indicated no significant adverse effects to terrestrial and aquatic fauna. While additional research in some areas is required, such as the use of glyphosate-based products in forests outside of North America, and the potential indirect effects of glyphosate stored in sediments, most of the priority questions have been addressed by scientific investigations. Based on the extensive available scientific evidence we conclude that glyphosate-based herbicides, as typically employed in planted forest management, do not pose a significant risk to humans and the terrestrial and aquatic environments.

Keywords: isopropylammonium; risk assessment; herbicides; glyphosate; forest vegetation management

Extract:

5. Risk of Toxicological Effects on Humans

Many studies have been conducted to determine the potential for glyphosate and glyphosate-based herbicides to induce toxic effects in humans and these studies have been extensively reviewed by regulatory agencies and internationally renowned scientific experts repeatedly through time [1,4,5,8,18,23,24].

As specifically related to the issue of potential cancer risk, with the exception of the International Agency for Research on Cancer (IARC) [11] report, regulatory agencies around the world have all conducted multiple reviews and consistently concluded that registered uses of glyphosate in accordance with label directions do not pose a cancer risk, or any other risk, to human health [23–26,123,124]. The seeming contradiction between the IARC [11] conclusion and all others is largely explained by the fact that all other agencies consider carcinogenic risk potential in relation to potential realistic levels of human exposure, whereas the IARC process considers evidence for a potential hazard, without consideration of possible exposure magnitude or routes.

Despite the general consensus on human and mammalian toxicity and risk as summarized in the aforementioned professional reviews there are relatively fewer such assessments specific to human exposure and potential effects associated with glyphosate use in the planted forest sector. Durkin [5,8] presents a human health risk assessment relating specifically to glyphosate based herbicides as they are used in forest management by the US Forest Service. In these assessments, exposure for both workers and members of the general public were considered. Based on a standard unit application rate of 1.12 kg a.i. ha⁻¹, Durkin [8] concluded that general exposure for workers applying glyphosate either via manual, ground or aerial application was considered minimal. Even at the highest labelled application rate of 9 kg a.i. ha⁻¹, the risk of exposure of workers to levels of glyphosate above the RfD of 2 mg kg⁻¹ day⁻¹ was considered below a level of concern [8]. Similar studies to that conducted by Durkin [8] have shown that operator exposure to residues of glyphosate during routine manual applications has not resulted in levels of exposure that exceed even the newly proposed EFSA [23] Acceptable Operator Exposure Levels (AOELs) (Table 2) [18,125,126].

Manual application of glyphosate based herbicides using a knapsack sprayer is widely used in planted forests in South Africa and Chile for the control of competitive vegetation pre- and post-planting [27,33]. The studies cited above represent similar working conditions to that encountered by labourers who manually apply glyphosate based herbicides in field conditions during the establishment of young trees. While the specific exposure of forest workers to glyphosate in some regions has not been evaluated, it is likely their levels of exposure would be similar to those assessed by Durkin [5,8] and Dost [127] unless it could be shown there were significant differences in the rate of glyphosate applied (kg ha⁻¹), the area treated (ha) and the time period (number of months per year or number of years) over which workers were exposed to residues of the herbicide.

Significant exposure of the general public to glyphosate based herbicides applied to managed planted forests is generally unlikely and almost certainly less than for applicators as discussed above, given the:

- (1) infrequent use of glyphosate in any one forested area (once or twice in the rotation);

- (2) typical remote location of these plantations;
- (3) restricted public access in privately owned forests and general lack of a rationale for the public to enter these sites and
- (4) low probability of public entry within a few days of treatment when residues are at their highest levels and when they are more likely to dislodge from treated surfaces.

In cases where the general public do enter treated sites shortly after treatment, potential routes of exposure could include ingestion of contaminated surface water, dermal sorption of residues dislodged from plant surfaces and/or ingestion of contaminated plants such as wild berries, mushrooms and other species commonly used as natural food sources. In their review of glyphosate the Canadian Pest Management Regulatory Agency [24] concluded that non-occupational risks from bystander dermal exposure when glyphosate was used according to label rates was not a concern. This outcome included the consumption of wild food (berries, birds, small and large mammals) that may be present in planted forests. In support of this conclusion, studies by Newton et al. [52], Couture et al. [21] and Durkin [5] indicated that there is no route of exposure or exposure scenario suggesting that the general public will be at risk from longer-term exposure to glyphosate under typical use conditions in planted forests vegetation management. Similarly, Legris and Couture [54], found no measurable residues in 31/32 edible tissue samples taken from hares (*Lepus americanus*), moose (*Alces alces*) and deer (*Odocoileus virginianus*) sampled from territories within glyphosate treated spray sites.

However, Durkin [8], identified consumption of contaminated water after an accidental spill as an (acute) exposure scenario that could reach, but not exceed, a level of concern for the general public. This same author also identified the only non-accidental exposure scenario of concern as the consumption of contaminated vegetation shortly after glyphosate is applied, particularly when applied at rates above 1.6 kg a.i. ha⁻¹. These potentially higher risk scenarios, both manageable, represent the only examples that could be of concern to forest managers. However, given the use patterns in forest management, the rapid degradation of this active ingredient, the phytotoxicity to fruit bearing shrubs (i.e., berries and plants dead in 4 to 6 weeks) and the ability to mitigate this risk through restriction of public access, we support the general contention that it is likely consumption of wild food is a low risk pathway for human exposure to glyphosate in the planted forest environment.

In forested catchments, the exposure of humans (and terrestrial fauna) to high levels of glyphosate in forest streams through consumption of contaminated surface waters is unlikely given the low risk of movement of glyphosate into stream water sources following application in planted forests, coupled with rapid degradation and dilution downstream, as described in Section 3. Moreover, there is no evidence that the use of glyphosate in forested catchments has resulted in levels of glyphosate in water bodies likely to exceed human health and drinking water standards (Section 4; Table 3). In forest soils, glyphosate is rarely detected below the upper 15 cm level of soils [51,52,57,60,61], indicating that it is very unlikely to percolate down through forest soils and into groundwater. Given that in forestry scenarios glyphosate use is much less frequent than that in agricultural situations the risk to humans from water consumption is low. In fact, forest are recognised globally for their importance in providing sources of high water quality drinking water [128,129].

In New Zealand, although herbicides are the most commonly detected pesticide in national surveys of groundwater, no glyphosate has yet been detected [130] despite the relatively high dependence on this active ingredient in agriculture and across primary industry [37]. Vereecken [22] reported on several studies in European agriculture that showed low level residues occurring infrequently in groundwater with no detections above drinking water standards in Denmark, the United Kingdom, the Netherlands or Norway. In a comprehensive assessment of the fate of glyphosate and AMPA in the USA, Battaglin et al. [131] found that both products were frequently detected in rivers and streams, less so in lakes and ponds and infrequently in groundwater. The author's noted that most glyphosate concentrations were below existing health benchmarks and levels of concern for humans. Similarly, a multi-year study of pesticide residues in four rivers in an agricultural region of southern Quebec showed the maximal concentrations of glyphosate ranging from 3.3 to 29.0 ppb [132]. Even maximum levels observed in these agricultural scenarios are far below the maximum acceptable concentration of 280 ppb established by Health Canada as protective of human health assuming a lifetime (70 years consumption) of 1.5 L of drinking water per day [133].

Appendix 6: Material Safety Data Sheets (SDS) for Glyphosate – Australia/NZ, EU and USA

Australia/New Zealand - Monsanto



SAFETY DATA SHEET

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1. Identification

Product name:	Concentrate Roundup® Weedkiller
Use:	For use as herbicide to control a wide range of weeds and grasses in garden beds, rockeries, driveways, along fence lines and garden edges, around buildings and prior to planting new lawns and garden areas.
Company name	MONSANTO AUSTRALIA LTD
address and contact details:	12/600 St Kilda Road Melbourne, Australia 3004. Telephone: (+61) 3 9522 7122 Fax: (+61) 3 9522 6122
	New Zealand Distributor: Tui Products Ltd Truman Lane, Te Maunga Mount Maunganui 3175 Telephone: (07) 575 2160 Fax: (07) 575 8462 Website: www.tuiproducts.co.nz
Emergency phone number:	New Zealand National Poisons Centre 0800 764 766 [0800 POISON]

2. Hazard Identification

Classified as hazardous according to the Hazardous Substances (Minimum Degrees of Hazard) Regulations 2001, New Zealand.

HSNO Approval Number: HSR000767

HSNO Classification(s): 9.1B

Pictogram(s):



Signal word:	Not applicable
Hazard Statement(s):	H411 Toxic to the aquatic environment with long lasting effects.
Prevention Statement(s):	P103 Read label before use. P273 Avoid release to environment.
Response Statement(s):	P391 Collect spillage.
Storage Statement(s):	-
Disposal Statement:	P501 Dispose of product and container in accordance with any local or National regulations.

3. Composition/Information on Ingredients

Ingredient	CAS No	Proportion (%w/w)
Isopropylamine salt of glyphosate *	38641-94-0	41 - 42
Surfactant, formulating agents and water	Proprietary	58 - 59

*The product is formulated to contain equivalent to 360 g/L glyphosate (CAS No 1071-83-6)

4. First Aid Measures

For advice or in an emergency, contact the National Poisons Centre, tel 0800 764 766 [0800 POISON] or a doctor. Have product label or this Safety Data Sheet at hand.

Inhalation:	In inhaled, move person to fresh air. Keep at rest in a position comfortable for breathing until recovered. Get medical advice if symptoms persist. If person is not breathing, seek immediate medical assistance and give artificial respiration, preferably mouth to mouth.
Ingestion:	Do NOT induce vomiting. Rinse mouth with water. Get immediate medical advice.
Skin:	Wash affected area with plenty of soap and water. If irritation persists or develops, get medical advice.
Eye contact:	Hold eyelids apart and flush continuously with water several minutes. Remove contact lenses if present, after the first 5 minutes and continue rinsing. If irritation persists or symptoms develop, seek immediate medical attention.
First Aid Facilities:	Eye wash and washroom facilities.
Advice to Doctor:	This product is not an inhibitor of cholinesterase.
Antidote:	Treatment with atropine and oximes is not indicated.

5. Fire-fighting measures

Flammability:	Product is non-combustible.
Suitable extinguishing media:	Water, foam, dry chemical or carbon dioxide (CO ₂) as appropriate for surrounding materials.
Hazards from combustion:	Toxic and/or, irritating fumes or gases that may include carbon oxides, phosphorous oxides, nitrogen oxides.
Decomposition temperature:	Not available.
Specific hazards:	Prevent extinguishing media from entering waterways, drains or sewers.
HAZCHEM Code:	3Z
Precautions for fire-fighters:	Wear Self-Contained Breathing Apparatus (SCBA) operated in positive pressure mode and full protective clothing to prevent exposure to vapours or fumes.

6. Accidental release measures

Emergency procedures:	Wear personal protection equipment and clothing to minimise exposure. Contain spill. If unable to recover liquid, absorb with an inert absorbent material. Collect
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and place in labelled container than can be sealed before disposal. If contamination of waterways, drains or sewers occurs, immediately inform local council and emergency services.

7. Handling and storage

Precautions for Safe Handling: Read label before use. Avoid inhalation of vapours and mists and contact with skin or eyes. Wear personal protection equipment and clothing to minimise exposure. Use in a well-ventilated area to avoid build-up of vapours and mists. Follow good occupational hygiene practices. Wash hands before eating, drinking, smoking or using toilet facilities. Wash contaminated clothing before re-use. Keep containers closed when not in use.

When mixing and/or applying, use only stainless steel, aluminium, brass, copper, fibreglass, plastic or plastic lined containers. Do NOT use galvanized steel or unlined steel (except stainless steel) as a reaction may produce hydrogen gas which is highly combustible and can flash or explode when ignited.

Conditions for Safe Storage: Keep out of reach of children. Store only in original container and away from food, drink and animal feed.

8. Exposure controls/personal protection

Health Exposure Standards: Workplace Exposure Standards (WES) have not been set by Worksafe NZ for this substance.

Biological limit values: None established

Personal Protective Equipment:

Respiratory Protection: Respiratory protection may be necessary under certain use conditions. Under such conditions, an approved respirator with a replaceable mist filter according to local standards (AS/NZS 1715), must be worn.

Eye Protection: Wear safety glass with side shields or safety goggles to avoid contact of solution with eyes.

Skin/ Body Protection: The wearing of impervious chemical resistant gloves, e.g. nitrile, neoprene, natural rubber, polyvinyl chloride (PVC) is recommended.

9. Physical and chemical properties

Form:	Liquid
Appearance:	Clear, pale amber
Odour:	Faint amine like
Melting point (°C):	No data
Boiling point (°C):	> 100
Decomposition temperature (°C):	No data
Flash point (°C):	Non flammable
Specific gravity (g/cc):	1.16 @ 25°C
pH:	4.4 – 5.0 (as 8% w/v aqueous solution)
Vapour pressure:	No data
Vapour density (Air=1):	No data
Evaporation rate:	No data
Solubility in water:	Soluble
Partition coefficient (log Pow):	-3.2 @ 25 °C (glyphosate)

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10. Stability and reactivity

- Chemical Stability:** Stable under normal conditions of storage and handling.
- Conditions to avoid:** Extremes of temperature and direct sunlight.
- Incompatible materials:** Contact with galvanized steel or unlined mild steel which may produce hydrogen, a highly flammable gas.
- Hazardous decomposition products:** Thermal decomposition may produce toxic or irritating fumes and gases; may include carbon oxides, phosphorous oxides and nitrogen oxides.
- Hazardous polymerization:** Does not occur.

11. Toxicological information

- Ingestion:** May irritate gastric tract and cause nausea and vomiting. Potentially harmful if swallowed in large quantities resulting in hypotension and pulmonary oedema.
- Inhalation:** Product vapours may be irritating to nose, throat and respiratory system.
- Eye Contact:** May be slightly irritating causing discomfort; redness, itching and/or tearing.
- Skin Contact:** May be slightly irritating causing discomfort; redness, itching and/or swelling.
- Other Health Effects:** Product is not identified as sensitizer, mutagen and carcinogen or with adverse effects on fertility or unborn child, or to organs or systems.
- Toxicological Information:**
For concentrate of similar product:
Oral LD₅₀ (rat) > 5000 mg/kg b.w.
Dermal LD₅₀ (rabbit) > 5000 mg/kg b.w.
Inhalation LC₅₀ 4 hr aerosol (rat) 2.3 mg/L

12. Ecological information

- Ecotoxicity:** This product is toxic to aquatic life with long-lasting effects.
- Persistence and degradability:** Absorption studies indicate that glyphosate has very low mobility. Average field half-life of glyphosate is 47 days.
- Mobility:** Glyphosate is strongly absorbed by soil and therefore becomes practically immobile. Microbial degradation is the major cause of loss from soil with liberation of carbon dioxide.
- Bioaccumulation:** Glyphosate is not bio-accumulative.
BCF = <1 for bluegill sunfish.
Log Pow -3.2 @ 25 °C (for glyphosate)
- Ecotoxicity Information:** For glyphosate in form of isopropylamine salt;
Bluegill sunfish (*Lepomis macrochirus*) LC₅₀ (96 h) 45 mg/L
Daphnia magna LC₅₀ (48 h) 930 mg/L
Skeletonema costatum (diatom) EC₅₀ (96 hr) 1.2 mg/L

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For glyphosate acid;
Rainbow trout (*Oncorhynchus mykiss*) LC₅₀ (96 hr) 86 mg/L
Bluegill sunfish (*Lepomis macrochirus*) LC₅₀ (96 h) 120 mg/L
Daphnia magna EC₅₀ (48 h) 780 mg/L
Bobwhite quail (*Colinus virginianus*) LD₅₀ > 3850 mg/kg
Honey bee (*Apis mellifera*) oral, LD₅₀ 100 µg/bee

Other Information: Environmental Exposure Limit (EEL) for glyphosate is 0.37 mg/L

13. Disposal considerations

Disposal Methods: Empty containers retain product residues and vapour. Triple rinse empty containers with water and use in spray mix. Do not allow product to enter drains or watercourses or dispose of where ground or surface waters may be affected.
Dispose of empty containers in accordance with local or National regulations.
Incinerate if appropriate facility/equipment is available. Do not use container for storing any other product.

14. Transport information

New Zealand This product is classified as a Dangerous Good, Class 9.
Please consult the Land Transport Rule: Dangerous Goods 2005, and
NZS 5433:2012 Transport of Dangerous Goods on Land for information.

UN Number: 3082

Proper Shipping Name: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S
(CONTAINS GLYPHOSATE)

DG Class: 9

Subsidiary Risk: -

Packing Group: III

HAZCHEM: 3Z



15. Regulatory information

New Zealand

Classified as hazardous according to the Hazardous Substances (Minimum Degrees of Hazard) Regulations 2001, New Zealand.

HSNO Approval number: HSR000767 Soluble concentrate containing 300 – 450 g/Litre glyphosate as the isopropylamine salt.

HSNO Controls: Refer to www.epa.govt.nz for all Controls relating to this product and use.

Note the additional Control 77A -Use restriction. Where the substance is applied onto or into water and the water has the potential to leave the place containing the application area, any application of the substance must be under the personal control of an approved handler.

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16. Other information

Date of Issue: 9 February 2015.
Reasons for issue: SDS for New Zealand use.
Replaces: Not applicable.

Abbreviations:

EC50	50% effect concentration
EEL	Environmental Exposure Limit
EPA	Environmental Protection Authority
HSNO	Hazardous Substance and New Organisms
LD50	50% lethal dose
STEL	Short Term Exposure Limit (15 minute exposure period)
TWA	Time-Weighted Average (8 hours exposure period)
WES	Workplace Exposure Standard

References:

EPA www.epa.govt.nz
 Supplier Safety Data Sheets

Other:

The information contained herein is given in good faith but no warranty, expressed or implied is made.
 Consult supplier if additional information or explanation is required.

End of safety data sheet

MONSANTO Europe S.A./N.V.Safety Data Sheet
Commercial Product**1. PRODUCT AND COMPANY IDENTIFICATION**

- 1.1. Product identifier**
Roundup® PowerMax
- 1.1.1. Chemical name**
 Not applicable for a mixture.
- 1.1.2. Synonyms**
 None.
- 1.1.3. CLP Annex VI Index No.**
 Not applicable.
- 1.1.4. C&L ID No.**
 Not available.
- 1.1.5. EC No.**
 Not applicable for a mixture.
- 1.1.6. REACH Reg. No.**
 Not applicable for a mixture.
- 1.1.7. CAS No.**
 Not applicable for a mixture.
- 1.2. Product use**
 Herbicide
- 1.3. Company/(Sales office)**
 MONSANTO Europe S.A./N.V.
 Haven 627, Scheldelaan 460, B-2040
 Antwerp, Belgium
Telephone: +32 (0)3 568 51 11
Fax: +32 (0)3 568 50 90
E-mail:
 safety.datasheet@monsanto.com
- 1.4. Emergency numbers**
Telephone: Belgium +32 (0)3 568 51 23

2. HAZARDS IDENTIFICATION

- 2.1. Classification**
- 2.1.1. Classification according to Regulation (EC) No. 1272/2008 [CLP] - U.K.**
 Not classified as dangerous.
- 2.2. Label elements**
 Labelling according to Regulation (EC) No. 1272/2008 [CLP]
- 2.2.1. Precautionary statement/statements U.K.**
 P234 Keep only in original container
- 2.2.2. Supplemental hazard information U.K.**
 EUH401 To avoid risks to human health and the environment, comply with the instructions for use.
- 2.3. Other hazards**
 0% of the mixture consists of ingredient/ingredients of unknown acute toxicity.
 0% of the mixture consists of ingredient/ingredients of unknown hazards to the aquatic environment.
- 2.3.1. Potential environmental effects**
 Not expected to produce significant adverse effects when recommended use instructions are followed.

Not a persistent, bioaccumulative or toxic (PBT) nor a very persistent, very bioaccumulative (vPvB) mixture.

2.4. Appearance and odour (colour/form/odour):
ivory cream /Granules / Chemical

Refer to section 11 for toxicological and section 12 for environmental information.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Active ingredient

Ammonium salt of N-(phosphonomethyl)glycine; {Ammonium salt of glyphosate}

Composition

Components	CAS No.	EC No.	EU Index No. / REACH Reg. No. / C&L ID No.	% by weight (approximate)	Classification
Ammonium salt of glyphosate	40465-66-5		- / - / -	79	Aquatic Chronic - Category 2; H411
Surfactant			- / - / -	12	Skin corrosion/irritation - Category 2, Eye damage/irritation - Category 2, Aquatic Acute - Category 1, Aquatic Chronic - Category 1; H315, 319, 400, 410; { d }
Minor formulating ingredients			- / - / -	8,5	
Sodium sulphite	7757-83-7		- / - / -	0,5	

The specific chemical identity is being withheld because it is trade secret information of Monsanto Company.

Full text of classification code: See section 16.

4. FIRST AID MEASURES

Use personal protection recommended in section 8.

4.1. Description of first aid measures

4.1.1. Eye contact

Immediately flush with plenty of water. If easy to do, remove contact lenses.

4.1.2. Skin contact

Take off contaminated clothing, wristwatch, jewellery. Wash affected skin with plenty of water. Wash clothes and clean shoes before re-use.

4.1.3. Inhalation

Remove to fresh air.

4.1.4. Ingestion

Immediately offer water to drink. Do NOT induce vomiting unless directed by medical personnel. If symptoms occur, get medical attention.

4.2. Most important symptoms and effects, both acute and delayed

4.2.1. Potential health effects

Likely routes of exposure: Skin contact, eye contact, inhalation, ingestion

Eye contact, short term: Not expected to produce significant adverse effects when recommended use instructions are followed.

Skin contact, short term: Not expected to produce significant adverse effects when recommended use instructions are followed.

Inhalation, short term: Not expected to produce significant adverse effects when recommended use instructions are followed.

- Single ingestion:** Not expected to produce significant adverse effects when recommended use instructions are followed.
- 4.2.2. Medical conditions aggravated by exposure**
Hypersensitivity to sulphiting agents.
Note: A very small percentage of particularly sensitive people may suffer skin or respiratory reactions.
- 4.3. Indication of any immediate medical attention and special treatment needed**
- 4.3.1. Advice to doctors**
This product is not an inhibitor of cholinesterase.
- 4.3.2. Antidote**
Treatment with atropine and oximes is not indicated.

5. FIRE-FIGHTING MEASURES

- 5.1. Extinguishing media**
- 5.1.1.** Recommended: Water, foam, dry chemical, carbon dioxide (CO₂)
- 5.2. Special hazards**
- 5.2.1. Unusual fire and explosion hazards**
Minimise use of water to prevent environmental contamination.
Environmental precautions: see section 6.
- 5.2.2. Hazardous products of combustion**
Carbon monoxide (CO), phosphorus oxides (P_xO_y), nitrogen oxides (NO_x), sulphur oxides (SO_x)
- 5.3. Fire fighting equipment**
Self-contained breathing apparatus. Equipment should be thoroughly decontaminated after use.
- 5.4. Flash point**
Not applicable.

6. ACCIDENTAL RELEASE MEASURES

Use handling recommendations in Section 7 and personal protection recommendations in Section 8.

- 6.1. Environmental precautions**
Keep out of drains, sewers, ditches and water ways. Do NOT contaminate water when disposing of rinse waters.
- 6.2. Methods for cleaning up**
SMALL QUANTITIES: Flush spill area with water. LARGE QUANTITIES: Dig up heavily contaminated soil. Collect in containers for disposal. Refer to section 7 for types of containers. Flush residues with small quantities of water. Minimise use of water to prevent environmental contamination.

Refer to section 13 for disposal of spilled material.

7. HANDLING AND STORAGE

Good industrial practice in housekeeping and personal hygiene should be followed.

- 7.1. Precautions for safe handling**
Avoid contact with eyes.
When using do not eat, drink or smoke.
Wash hands thoroughly after handling or contact.
Wash contaminated clothing before re-use.
Thoroughly clean equipment after use.
Do not contaminate drains, sewers and water ways when disposing of equipment rinse water.
Refer to section 13 of the safety data sheet for disposal of rinse water.

Emptied containers retain vapour and product residue.
FOLLOW LABELLED WARNINGS EVEN AFTER CONTAINER IS EMPTIED.

7.2. Conditions for safe storage

Compatible materials for storage: stainless steel, aluminium, fibreglass, plastic, glass lining
Keep out of reach of children.
Keep away from food, drink and animal feed.
Keep only in the original container.
Keep container dry.
Keep container off wet floors.
Minimum shelf life: 2 years.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Airborne exposure limits

Components	Exposure Guidelines
Ammonium salt of glyphosate	No specific occupational exposure limit has been established.
Surfactant	No specific occupational exposure limit has been established.
Minor formulating ingredients	No specific occupational exposure limit has been established.
Sodium sulphite	No specific occupational exposure limit has been established.

8.2. Engineering controls

Have eye wash facilities immediately available at locations where eye contact can occur.

8.3. Recommendations for personal protective equipment

8.3.1. Eye protection:

If there is significant potential for contact: Wear dust goggles.

8.3.2. Skin protection:

If repeated or prolonged contact:
Wear chemical resistant gloves.

8.3.3. Respiratory protection:

No special requirement when used as recommended.

When recommended, consult manufacturer of personal protective equipment for the appropriate type of equipment for a given application.

9. PHYSICAL AND CHEMICAL PROPERTIES

These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specifications for the product.

Colour/colour range:	ivory cream
Odour:	Chemical
Form:	Granules
Physical form changes (melting, boiling, etc.):	
Melting point:	No data.
Flash point:	Not applicable.
Explosive properties:	No explosive properties
Auto ignition temperature:	Does not self-ignite.
Self-accelerating decomposition temperature (SADT):	No data.

Oxidizing properties:	none
Specific gravity:	Not applicable.
Vapour pressure:	No significant volatility.
Vapour density:	Not applicable.
Evaporation rate:	Not applicable.
Dynamic viscosity:	Not applicable.
Kinematic viscosity:	Not applicable.
Density:	0,55 g/cm ³ ; (loose bulk density)
Solubility:	Water: Soluble
pH:	3,8 @ 20 °C @ 10 g/l
Partition coefficient:	log Pow: -3,02 @ 25 °C (glyphosate)

10. STABILITY AND REACTIVITY

10.1. Reactivity

Reacts with galvanised steel or unlined mild steel to produce hydrogen, a highly flammable gas that could explode.

10.2. Stability

Stable under normal conditions of handling and storage.

10.3. Possibility of hazardous reactions

Reacts with galvanised steel or unlined mild steel to produce hydrogen, a highly flammable gas that could explode.

10.4. Incompatible materials

Incompatible materials for storage: galvanised steel, unlined mild steel
Compatible materials for storage: see section 7.2.

10.5. Hazardous decomposition

Thermal decomposition: Hazardous products of combustion: see section 5.

11. TOXICOLOGICAL INFORMATION

This section is intended for use by toxicologists and other health professionals.

Likely routes of exposure: Skin contact, eye contact, inhalation, ingestion

Data obtained on product and components are summarized below.

Acute oral toxicity

Rat, LD₅₀ (Method: Up-and-down procedure (OECD 425)): > 5.000 mg/kg body weight
No mortality. Practically non-toxic.

Acute dermal toxicity

Rat, LD₅₀: > 5.000 mg/kg body weight
No mortality. Practically non-toxic.

Acute inhalation toxicity

Rat, LC₅₀, 4 hours, aerosol:

No 4-hr LC₅₀ at the maximum tested concentration. No mortality. For purposes of the inhalation test, product was artificially aerosolized. Since this material will not become aerosolized to a hazardous concentration during transport, it is classified as non-hazardous under the transportation regulations in accordance with 2.6.2.2.4.7(b) and (c) of the UN Recommendations on the Transport of Dangerous Goods. This product is not aerosolized during handling or use and is therefore not classified as hazardous under the CLP Regulation (EC 1272/2008). Practically non-toxic.

Skin irritation

Rabbit, 3 animals, OECD 404 test:

Redness, individual EU scores: 1,00; 1,00; 1,00
Swelling, individual EU scores: 0,33; 0,33; 0,33
Days to heal: 3
Slightly irritating to skin but not sufficient for classification.

Slight irritation.

Eye irritation

Rabbit, 3 animals, OECD 405 test:

Conjunctival redness, individual EU scores: 1,33; 0,67; 1,33
Conjunctival swelling, individual EU scores: 0,33; 0,33; 0,67
Corneal opacity, individual EU scores: 0,00; 0,00; 0,00
Iris lesions, individual EU scores: 0,00; 0,00; 0,00
Days to heal: 3
Slightly irritating to eyes but not sufficient for classification.
Slight irritation.

Skin sensitization

Guinea pig, 9-induction Buehler test:

Positive incidence: 0 %
Negative.

N-(phosphonomethyl)glycine; { glyphosate acid}

Genotoxicity

Not genotoxic.

Carcinogenicity

Not carcinogenic in rats or mice.

Reproductive/Developmental Toxicity

Developmental effects in rats and rabbits only in the presence of significant maternal toxicity.
Reproductive effects in rats only in the presence of significant maternal toxicity.

Sodium sulphite

EXPERIENCE WITH HUMAN EXPOSURE

Eye contact, excessive, occupational:

Eye effects: irritation

Skin contact, excessive, occupational:

Skin effects: irritation, sensitization in susceptible individuals

Inhalation, excessive, occupational:

Respiratory effects: Respiratory sensitization, irritation, asthma

Ingestion, short term, case report(s):

Gastro-intestinal effects: irritation

Ingestion, excessive, case report(s):

Gastro-intestinal effects: diarrhoea, abdominal pain
Cardiovascular effects: decreased blood pressure (hypotension)

12. ECOLOGICAL INFORMATION

This section is intended for use by ecotoxicologists and other environmental specialists.

Data obtained on product and components are summarized below.

Aquatic toxicity, fish

Zebra fish (*Brachydanio rerio*):

Acute toxicity, 96 hours, static, EC50: 102 mg/L

Aquatic toxicity, invertebrates

Water flea (*Daphnia magna*):

Acute toxicity (limit test), 48 hours, static, EC50: > 100 mg/L

Aquatic toxicity, algae/aquatic plants

Green algae (*Pseudokirchneriella subcapitata*):

Acute toxicity, 72 hours, ErC50 (growth rate): 51 mg/L

Green algae (*Pseudokirchneriella subcapitata*):

Acute toxicity, 72 hours, NOEC: 10 mg/L

Avian toxicity

Japanese quail (*Coturnix coturnix japonica*):

Acute oral toxicity (limit test), single dose, LD50: > 2.000 mg/kg body weight

Arthropod toxicity

Honey bee (*Apis mellifera*):

Contact, 48 hours, LD50: > 100 µg/bee

Honey bee (*Apis mellifera*):

Oral, 48 hours, LD50: > 104,8 µg/bee

Soil organism toxicity, invertebrates

Earthworm (*Eisenia foetida*):

Acute toxicity (limit test), 14 days, LC50: > 1.000 mg/kg dry soil

Soil organism toxicity, microorganisms

Nitrogen and carbon transformation test:

3,5 kg/ha, 28 days: Less than 25% effect on nitrogen or carbon transformation processes in soil.

N-(phosphonomethyl)glycine: { glyphosate acid}

Avian toxicity

Bobwhite quail (*Colinus virginianus*):

Acute oral toxicity, single dose, LD50: > 3.851 mg/kg body weight

Bioaccumulation

Bluegill sunfish (*Lepomis macrochirus*):

Whole fish: BCF: < 1

No significant bioaccumulation is expected.

Dissipation

Soil, field:

Half life: 2 - 174 days

Koc: 884 - 60.000 L/kg

Adsorbs strongly to soil.

Water, aerobic:

Half life: < 7 days

13. DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

13.1.1. Product

Keep out of drains, sewers, ditches and water ways. Follow all local/regional/national/international regulations on waste disposal. Follow current edition of the General Waste, Landfill, and Burning of Hazardous Waste Directives; and the Shipment of Waste Regulation. According to the manufacturer self-classification, following Regulation (EC) No. 1272/2008 [CLP], the product can be disposed as a non-hazardous industrial waste. Disposal in a waste incinerator with energy recovery is recommended.

13.1.2. Container

Follow all local/regional/national/international regulations on waste disposal, packaging waste collection/disposal. Follow current edition of the General Waste, Landfill, and Burning of Hazardous Waste Directives; and the Shipment of Waste Regulation. Do not re-use bags. Empty and shake the bag; inspect for emptiness/cleanliness. Empty inspected bags can be disposed of as non hazardous industrial waste. Store for collection by approved waste disposal service. Recycle if appropriate facilities/equipment available. Recycle the non-hazardous bag only when a proper control on the end use of the recycled plastic is possible. Suitable for industrial grade recycling only. Do NOT recycle plastic that could end in any human or food contact application. The empty plastic bag meets the requirements for energy recovery. Disposal in a incinerator with energy recovery is recommended.

Use handling recommendations in Section 7 and personal protection recommendations in Section 8.

14. TRANSPORT INFORMATION

The data provided in this section is for information only. Please apply the appropriate regulations to properly classify your shipment for transportation.

Not regulated for transport under ADR/RID, IMO, or IATA/ICAO Regulations

15. REGULATORY INFORMATION

15.1. Other Regulatory Information

SPI Do not contaminate water with the product or its container.

15.2. Chemical Safety Assessment

A Chemical Safety Assessment per Regulation (EC) No. 1907/2006 is not required and has not been performed.

A Risk Assessment has been performed under Regulation EC 1107/2009.

16. OTHER INFORMATION

The information given here is not necessarily exhaustive but is representative of relevant, reliable data.

Follow all local/regional/national/international regulations.

Please consult supplier if further information is needed.

This Safety Data Sheet has been prepared following the Regulation (EC) No. 1907/2006 (Annex II) as last amended by Regulation (EC) No. 2015/830

In this document the British spelling was applied.

Data provided in this Safety Data Sheet are for the product as supplied unless otherwise indicated.

Classification of components

Components	Classification
Ammonium salt of glyphosate	Aquatic Chronic - Category 2 H411 Toxic to aquatic life with long lasting effects.
Surfactant	Skin corrosion/irritation - Category 2 Eye damage/irritation - Category 2 Aquatic Acute - Category 1 Aquatic Chronic - Category 1 H315 Causes skin irritation. H319 Causes serious eye irritation. H400 Very toxic to aquatic life. H410 Very toxic to aquatic life with long lasting effects.
Minor formulating ingredients	
Sodium sulphite	

Endnotes:

{ a } EU label (manufacturer self-classification)

{ b } EU label (Annex I)

{ c } EU CLP classification (Annex VI)

{ d } EU CLP (manufacturer self-classification)

Full denomination of most frequently used acronyms. BCF (Bioconcentration Factor), BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), EC50 (50% effect concentration), ED50 (50% effect dose), I.M. (intramuscular), I.P. (intraperitoneal), I.V. (intravenous), Koc (Soil adsorption coefficient), LC50 (50% lethality concentration), LD50 (50% lethality dose), LDLo (Lower limit of lethal dosage), LEL (Lower Explosion Limit), LOAEC (Lowest Observed Adverse Effect Concentration), LOAEL (Lowest Observed Adverse Effect Level), LOEC (Lowest Observed Effect Concentration), LOEL (Lowest Observed Effect Level), MEL (Maximum Exposure limit), MTD (Maximum Tolerated Dose), NOAEC (No Observed Adverse Effect Concentration), NOAEL (No Observed Adverse Effect Level), NOEC (No Observed Effect Concentration), NOEL (No Observed Effect Level), OEL (Occupational Exposure Limit), PEL (Permissible Exposure Limit), PII (Primary Irritation Index), Pow (Partition coefficient n-octanol/water), S.C. (subcutaneous), STEL (Short-Term Exposure Limit), STOT SE (Specific Target Organ Toxicity, Single Exposure), STOT RE (Specific Target Organ Toxicity, Repeated Exposure), TLV-C (Threshold Limit Value-Ceiling), TLV-TWA (Threshold Limit Value - Time Weighted Average), UEL (Upper Explosion Limit)

Although the information and recommendations set forth herein (hereinafter "Information") are presented in good faith and believed to be correct as of the date hereof, MONSANTO Company or any of its subsidiaries makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for the purposes prior to use. In no event will MONSANTO Company or any of its subsidiaries be responsible for damages of any nature whatsoever resulting from the use of or reliance upon information. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR TO THE PRODUCT TO WHICH INFORMATION REFERS.

Safety Data Sheet (SDS) Annex

Chemical Safety Report:
Read and follow label instructions.

000000048152

End of document

MONSANTO COMPANYMaterial Safety Data Sheet
Commercial Product**1. PRODUCT AND COMPANY IDENTIFICATION****Product name****Roundup PRO® Concentrate Herbicide****EPA Reg. No.**

524-529

Chemical name

Not applicable.

Synonyms

None.

Company

MONSANTO COMPANY, 800 N. Lindbergh Blvd., St. Louis, MO, 63167

Telephone: 800-332-3111, **Fax:** 314-694-5557**Emergency numbers**

FOR CHEMICAL EMERGENCY, SPILL LEAK, FIRE, EXPOSURE, OR ACCIDENT Call CHEMTREC - Day or Night: 1-800-424-9300 toll free in the continental U.S., Puerto Rico, Canada, or Virgin Islands. For calls originating elsewhere: 703-527-3887 (collect calls accepted).

FOR MEDICAL EMERGENCY - Day or Night: +1 (314) 694-4000 (collect calls accepted).

2. COMPOSITION/INFORMATION ON INGREDIENTS**Active ingredient**

Isopropylamine salt of N-(phosphonomethyl)glycine; {Isopropylamine salt of glyphosate}

Composition

COMPONENT	CAS No.	% by weight (approximate)
Isopropylamine salt of glyphosate	38641-94-0	50.2
Other ingredients		49.8

The specific chemical identity is being withheld because it is trade secret information of Monsanto Company.

OSHA Status

This product is hazardous according to the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

3. HAZARDS IDENTIFICATION**Emergency overview****Appearance and odour (colour/form/odour):** Amber - Brown / Liquid, (viscous) / Slight

CAUTION!

CAUSES MODERATE EYE IRRITATION

Potential health effects**Likely routes of exposure**

Skin contact, eye contact, inhalation

Eye contact, short term

May cause temporary eye irritation.

Skin contact, short term

Not expected to produce significant adverse effects when recommended use instructions are followed.

Inhalation, short term

Not expected to produce significant adverse effects when recommended use instructions are followed.

Refer to section 11 for toxicological and section 12 for environmental information.

4. FIRST AID MEASURES

Eye contact

Immediately flush with plenty of water.
Continue for at least 15 minutes.
If easy to do, remove contact lenses.
If there are persistent symptoms, obtain medical advice.

Skin contact

Immediately wash affected skin with plenty of water.
Take off contaminated clothing, wristwatch, jewellery.
Wash clothes and clean shoes before re-use.

Inhalation

Remove to fresh air.

Ingestion

Immediately offer water to drink.
Never give anything by mouth to an unconscious person.
Do NOT induce vomiting unless directed by medical personnel.
If symptoms occur, get medical attention.

Advice to doctors

This product is not an inhibitor of cholinesterase.

Antidote

Treatment with atropine and oximes is not indicated.

5. FIRE-FIGHTING MEASURES

Flash point

None.

Extinguishing media

Recommended: Water, foam, dry chemical, carbon dioxide (CO₂)

Unusual fire and explosion hazards

Minimise use of water to prevent environmental contamination.
Environmental precautions: see section 6.

Hazardous products of combustion

Carbon monoxide (CO), nitrogen oxides (NO_x), phosphorus oxides (P_xO_y)

Fire fighting equipment

Self-contained breathing apparatus.
Equipment should be thoroughly decontaminated after use.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions

Use personal protection recommended in section 8.

Environmental precautions

SMALL QUANTITIES:

Low environmental hazard.

LARGE QUANTITIES:

Minimise spread.

Contain spillage with sand bags or other means.

Keep out of drains, sewers, ditches and water ways.

Notify authorities.

Methods for cleaning up

Absorb in earth, sand or absorbent material.

Dig up heavily contaminated soil.

Collect in containers for disposal.

Refer to section 7 for types of containers.

Flush residues with small quantities of water.

Minimise use of water to prevent environmental contamination.

Refer to section 13 for disposal of spilled material.

7. HANDLING AND STORAGE

Good industrial practice in housekeeping and personal hygiene should be followed.

Storage

Compatible materials for storage: stainless steel, aluminium, fibreglass, plastic

Incompatible materials for storage: unlined mild steel, galvanised steel, see section 10.

Keep out of reach of children.

Keep away from food, drink and animal feed.

Keep only in the original container.

Shelf life currently under test.

Recommended maximum shelf life: 2 years.

Follow all local/regional/national/international regulations.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Airborne exposure limits

Components	Exposure Guidelines
Isopropylamine salt of glyphosate	No specific occupational exposure limit has been established.
Other ingredients	No specific occupational exposure limit has been established.

Engineering controls

No special requirement when used as recommended.

Eye protection

If there is significant potential for contact:

Wear chemical goggles.

Applicators and other handlers must wear eye protection.

Skin protection

If repeated or prolonged contact:

Wear chemical resistant gloves.

Respiratory protection

No special requirement when used as recommended.

When recommended, consult manufacturer of personal protective equipment for the appropriate type of equipment for a given application.

9. PHYSICAL AND CHEMICAL PROPERTIES

These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specifications for the product.

Colour/colour range:	Amber - Brown
Form:	Liquid, (viscous)
Odour:	Slight
Flash point:	None.
Specific gravity:	1.199
pH:	4.8

10. STABILITY AND REACTIVITY

Stability

Stable under normal conditions of handling and storage.

Hazardous decomposition

Thermal decomposition: Hazardous products of combustion: see section 5.

Materials to avoid/Reactivity

Reacts with galvanised steel or unlined mild steel to produce hydrogen, a highly flammable gas that could explode.

11. TOXICOLOGICAL INFORMATION

This section is intended for use by toxicologists and other health professionals.

Data obtained on similar products and on components are summarized below.

Similar formulation

Acute oral toxicity

Rat, LD50: > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.

Acute dermal toxicity

Rat, LD50: > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.

Skin irritation

Rabbit, 6 animals, OECD 404 test:
Days to heal: 10
Primary Irritation Index (PII): 1.7/8.0
Slight irritation.
FIFRA category IV.

Eye irritation

Rabbit, 6 animals, OECD 405 test:
Days to heal: 7
Moderate irritation.

FIFRA category III.

Acute inhalation toxicity

Rat, LC50, 4 hours, aerosol:

Practically non-toxic.

FIFRA category IV.

No 4-hr LC50 at the maximum achievable concentration.

Skin sensitization

Guinea pig, Buehler test:

Positive incidence: 0 %

Negative.

No skin sensitization

N-(phosphonomethyl)glycine; (glyphosate)

Mutagenicity

In vitro and in vivo mutagenicity test(s):

Not mutagenic.

Repeated dose toxicity

Rabbit, dermal, 21 days:

NOAEL toxicity: > 5,000 mg/kg body weight/day

Target organs/systems: none

Other effects: none

Rat, oral, 3 months:

NOAEL toxicity: > 20,000 mg/kg diet

Target organs/systems: none

Other effects: none

Chronic effects/carcinogenicity

Mouse, oral, 24 months:

NOEL tumour: > 30,000 mg/kg diet

NOAEL toxicity: ~ 5,000 mg/kg diet

Tumours: none

Target organs/systems: liver

Other effects: decrease of body weight gain, histopathologic effects

Rat, oral, 24 months:

NOEL tumour: > 20,000 mg/kg diet

NOAEL toxicity: ~ 8,000 mg/kg diet

Tumours: none

Target organs/systems: eyes

Other effects: decrease of body weight gain, histopathologic effects

Toxicity to reproduction/fertility

Rat, oral, 2 generations:

NOAEL toxicity: 10,000 mg/kg diet

NOAEL reproduction: > 30,000 mg/kg diet

Target organs/systems in parents: none

Other effects in parents: decrease of body weight gain

Target organs/systems in pups: none

Other effects in pups: decrease of body weight gain

Effects on offspring only observed with maternal toxicity.

Developmental toxicity/teratogenicity

Rat, oral, 6 - 19 days of gestation:

NOAEL toxicity: 1,000 mg/kg body weight

NOAEL development: 1,000 mg/kg body weight

Other effects in mother animal: decrease of body weight gain, decrease of survival

Developmental effects: weight loss, post-implantation loss, delayed ossification

Effects on offspring only observed with maternal toxicity.

Rabbit, oral, 6 - 27 days of gestation:

NOAEL toxicity: 175 mg/kg body weight

NOAEL development: 175 mg/kg body weight
Target organs/systems in mother animal: none
Other effects in mother animal: decrease of survival
Developmental effects: none

12. ECOLOGICAL INFORMATION

This section is intended for use by ecotoxicologists and other environmental specialists.

Data obtained on similar products and on components are summarized below.

Similar formulation

Aquatic toxicity, fish

Rainbow trout (*Oncorhynchus mykiss*):

Acute toxicity, 96 hours, static, LC50: 5.4 mg/L
Moderately toxic.

Bluegill sunfish (*Lepomis macrochirus*):

Acute toxicity, 96 hours, static, LC50: 7.3 mg/L
Moderately toxic.

Aquatic toxicity, invertebrates

Water flea (*Daphnia magna*):

Acute toxicity, 48 hours, static, EC50: 11 mg/L
Slightly toxic.

Avian toxicity

Mallard duck (*Anas platyrhynchos*):

Dietary toxicity, 5 days, LC50: > 5,620 mg/kg diet
Practically non-toxic.

Bobwhite quail (*Colinus virginianus*):

Dietary toxicity, 5 days, LC50: > 5,620 mg/kg diet
Practically non-toxic.

Arthropod toxicity

Honey bee (*Apis mellifera*):

Oral/contact, 48 hours, LD50: > 100 µg/bee
Practically non-toxic.

Soil organism toxicity, invertebrates

Earthworm (*Eisenia foetida*):

Acute toxicity, 14 days, LC50: > 1,250 mg/kg soil
Practically non-toxic.

Isopropylamine salt of glyphosate (62%)

Aquatic toxicity, algae/aquatic plants

Green algae (*Scenedesmus subspicatus*):

Acute toxicity, 72 hours, static, EbC50 (biomass): 72.9 mg/L
Slightly toxic.

N-(phosphonomethyl)glycine: (glyphosate)

Bioaccumulation

Bluegill sunfish (*Lepomis macrochirus*):

Whole fish: BCF: < 1
No significant bioaccumulation is expected.

Dissipation

Soil, field:

Half life: 2 - 174 days

Koc: 884 - 60,000 L/kg
Adsorbs strongly to soil.

Water, aerobic:

Half life: < 7 days

13. DISPOSAL CONSIDERATIONS

Product

Recycle if appropriate facilities/equipment available.
Burn in special, controlled high temperature incinerator.
Keep out of drains, sewers, ditches and water ways.
Follow all local/regional/national/international regulations.

Container

See the individual container label for disposal information.
Triple or pressure rinse empty containers.
Pour rinse water into spray tank.
Store for collection by approved waste disposal service.
Recycle if appropriate facilities/equipment available.
Emptied containers retain vapour and product residue.
Observe all labelled safeguards until container is cleaned, reconditioned or destroyed.
Follow all local/regional/national/international regulations.

14. TRANSPORT INFORMATION

The data provided in this section is for information only. Please apply the appropriate regulations to properly classify your shipment for transportation.

Not hazardous under the applicable DOT, ICAO/IATA, IMO, TDG and Mexican regulations.

15. REGULATORY INFORMATION

TSCA Inventory

All components are on the US EPA's TSCA Inventory

OSHA Hazardous Components

Surfactant(s)

SARA Title III Rules

Section 311/312 Hazard Categories
Immediate
Section 302 Extremely Hazardous Substances
Not applicable.
Section 313 Toxic Chemical(s)
Not applicable.

CERCLA Reportable quantity

Not applicable.

16. OTHER INFORMATION

The information given here is not necessarily exhaustive but is representative of relevant, reliable data.
Follow all local/regional/national/international regulations.
Please consult supplier if further information is needed.
In this document the British spelling was applied.

	Health	Flammability	Instability	Additional Markings
NFPA	1	1	1	
0 = Minimal hazard, 1 = Slight hazard, 2 = Moderate hazard, 3 = Severe hazard, 4 = Extreme hazard				

Full denomination of most frequently used acronyms. BCF (Bioconcentration Factor), BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), EC50 (50% effect concentration), ED50 (50% effect dose), I.M. (intramuscular), I.P. (intraperitoneal), I.V. (intravenous), Koc (Soil adsorption coefficient), LC50 (50% lethality concentration), LD50 (50% lethality dose), LDLo (Lower limit of lethal dosage), LEL (Lower Explosion Limit), LOAEC (Lowest Observed Adverse Effect Concentration), LOAEL (Lowest Observed Adverse Effect Level), LOEC (Lowest Observed Effect Concentration), LOEL (Lowest Observed Effect Level), MEL (Maximum Exposure limit), MTD (Maximum Tolerated Dose), NOAEC (No Observed Adverse Effect Concentration), NOAEL (No Observed Adverse Effect Level), NOEC (No Observed Effect Concentration), NOEL (No Observed Effect Level), OEL (Occupational Exposure Limit), PEL (Permissible Exposure Limit), PII (Primary Irritation Index), Pow (Partition coefficient n-octanol/water), S.C. (subcutaneous), STEL (Short-Term Exposure Limit), TLV-C (Threshold Limit Value-Ceiling), TLV-TWA (Threshold Limit Value - Time Weighted Average), UEL (Upper Explosion Limit)

This Material Safety Data Sheet (MSDS) serves different purposes than and DOES NOT REPLACE OR MODIFY THE EPA-APPROVED PRODUCT LABELING (attached to and accompanying the product container). This MSDS provides important health, safety, and environmental information for employers, employees, emergency responders and others handling large quantities of the product in activities generally other than product use, while the labeling provides that information specifically for product use in the ordinary course. Use, storage and disposal of pesticide products are regulated by the EPA under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) through the product labeling, and all necessary and appropriate precautionary, use, storage, and disposal information is set forth on that labeling. It is a violation of federal law to use a pesticide product in any manner not prescribed on the EPA-approved label.

Although the information and recommendations set forth herein (hereinafter "Information") are presented in good faith and believed to be correct as of the date hereof, MONSANTO Company or any of its subsidiaries makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for the purposes prior to use. In no event will MONSANTO Company or any of its subsidiaries be responsible for damages of any nature whatsoever resulting from the use of or reliance upon information. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR TO THE PRODUCT TO WHICH INFORMATION REFERS.

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Appendix 7: Procedure for reporting and tracking adverse reactions to exposure to Glyphosate and other Designated HH pesticides.

Any persons injured by exposure to glyphosate or other designated Highly Hazardous substances, or displaying symptoms of allergic reaction or poisoning from exposure, while working in Ernslaw's FSC certified forests should be immediately directed to seek medical assistance, regardless of the duration of the exposure or exposure elsewhere, and their GP should be requested to note the occurrence in **HSDirt** (the NZ Hazardous Substances Disease and Injury Reporting Tool) on notification or complaint.

Contractors must be advised that adverse reactions to glyphosate or other designated Highly Hazardous substances noted during annual medical checks by a healthcare professional, or returned to Ernslaw via the voluntary Chemical Handlers/Applicators Questionnaire (Silvi manual form Document 8Q) must be escalated to trigger an assessment by a GP with notification into **HSDirt**.

Note that Public Health Units in NZ follow a "graded response protocol" because chemical-exposure incidents do not always create a health hazard.

The risk of developing health effects depends on the nature and scale of the chemical exposure. A graded response is based on the following three elements:

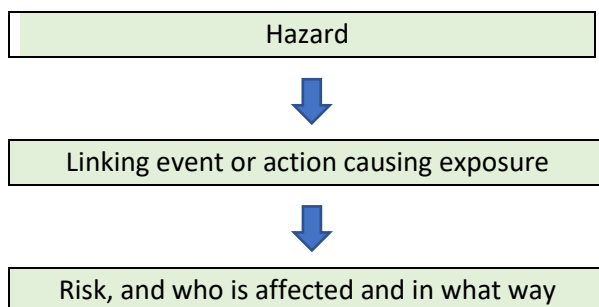
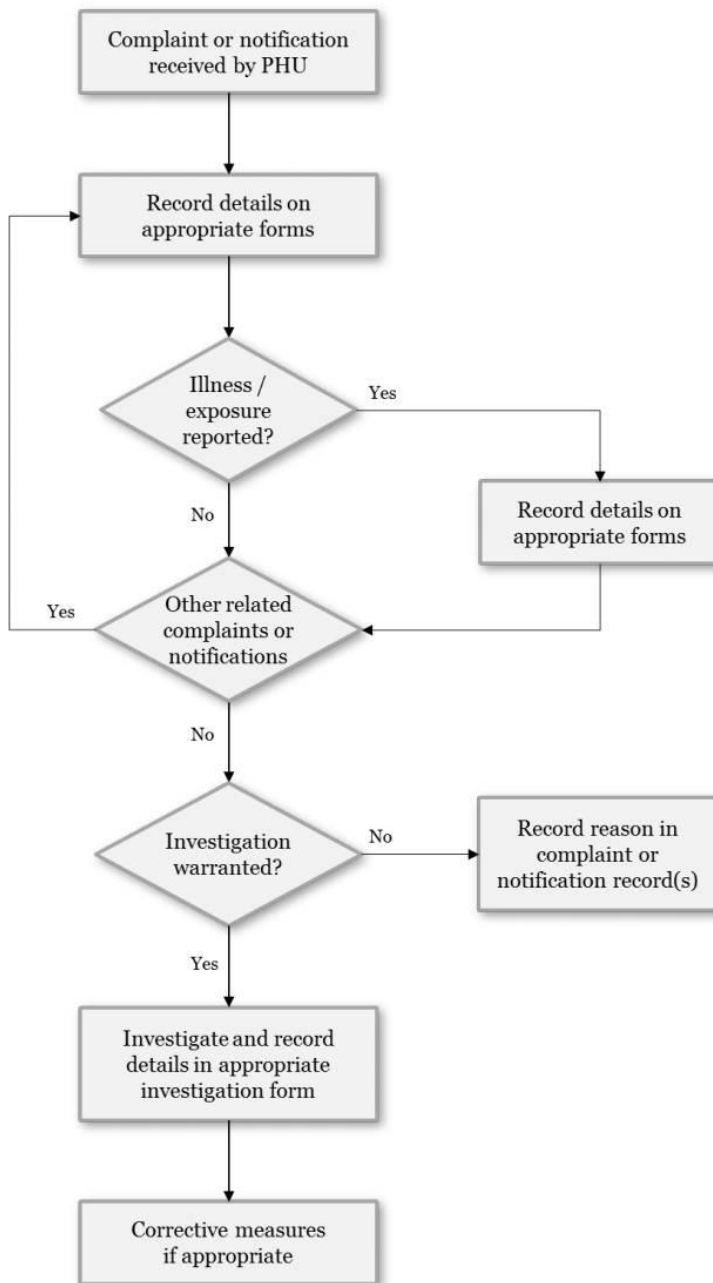


Figure 1 (overleaf) shows the Public Health Unit assessment process in use in NZ with steps that will trigger an investigation and where necessary corrective actions.

www.health.govt.nz/system/files/documents/publications/investigation-surveillance-poisoning-hazardous-substance-injuries-guidelines-public-health-units-mar2019.pdf

Guidance is provided for assigning case status in the User's Guide for Public Health Units available at: www.ehinz.ac.nz/assets/Other/HSDIRT-PHU-Users-Guide2017-Released-May2017.pdf

Figure 1: Overview of the process from receipt of a complaint or notification to investigation and outcome



At the end of the investigation it is necessary to decide whether further action (such as a prosecution, a referral to other authorities or a requirement for particular precautionary measures to be put in place) is appropriate. When dealing with Health Act or HSNO Act notifications, the Hazardous Substances Disease and Injury Reporting Tool (HSDIRT) requires the public health unit to assign a case status of definite, probable, possible, not a case, or insufficient information to assign case status.