Staff Report

for the Board of Directors Meeting of April 14, 2021

TO: Board of Directors

FROM: Robert A. MacDonald, Interim Maintenance Manager

DATE: April 6, 2021

SUBJECT: **Integrated Vegetation Management (IVM) Update**

MAINTENANCE

RECOMMENDATION:
Receive an update on the District's IVM Program and a presentation from Blankinship & Associates on the Study on Glyphosate Alternatives.

BACKGROUND:
NID maintains vegetation along 450 miles of canal, from the valley floor to upwards of the 3,000-foot elevation level, throughout the District's 287,000-acre service territory. Many of the District's canals have their own micro-ecosystem with unique features, such as canopy cover, hill slope, soil types, and air and water temperature differences. Of the 450 miles of canal, roughly 80 miles are accessible by full-sized pickup trucks, 290 miles are accessible by small tractors and UTVs/ATVs, and 80 miles are accessible only on foot. All canals traverse private property and many require more than one access method to reach all points of the canal.

An ongoing and increasingly difficult issue facing NID's canal maintenance program is the nuanced and unique interface of increased population, new homes or homeowners adjusting access, and varied vegetation species affecting the District's ability to reliably deliver water from source to customer. NID continues to provide adaptive management in order to keep canal and vegetation maintenance programs safe, environmentally conscious, and family-friendly while providing cost-efficient solutions for ratepayers.

Pilot Studies

From 2017 through 2020, NID initiated a 2-phased evaluation of alternative vegetation management strategies in place of the use of glyphosate.

- The first phase included three studies: (1) NID's collaborative Working Group formed to discuss the current usage of herbicides and possible alternatives for the District's

IVM Program; (2) field testing of alternative organic herbicides; and (3) field testing of mechanical vegetation control approaches. Topography, elevation, and various vegetation species were taken into account, as well as the efficacy of 9 organic herbicides (Axxe, Avenger Concentrate, Finalsan, Suppress EC, Opportune, Axxe + Opportune, Scythe, Weed Slayer, and Phydura), 2 mechanical treatment methods (abrasion weeder and steamer) and biological goat grazing.

On July 28, 2020, the Maintenance & Resource Managaement Committee received an update and presentation of the IVM Program Phase 3 Report, as attached.

- The second phase included a research study conducted by Blankinship & Associates on the costs incurred by various state agencies that have successfully removed glyphosate from their vegetation management programs.

  Total consultant costs to this period totaled $129,700.00.

The culmination of these studies have presented efficacy, efficiency, and cost-related information for budgetary planning and Board direction for the District's IVM Program.

As discussed in the Phase 3 Report, alternative herbicide applications did not demonstrate results within the target impact range (80% to 100%) of vegetation control, supportive of water quality and health. However, a modified protocol with an increased application frequency may demonstrate and sustain results of vegetation response in the target impact range. As noted in the Phase 3 Report, an increased application frequency will also result in increased demand on District resources, including material and labor. Of interest, the abrasion weeder and steamer units showed some promise; however, further testing in applicable locations would be needed to verify equipment cost and reliance on large quantities of alternative resources.

2021 and Beyond

In an effort to build off the previous studies and findings, while promoting an effort to effectively remove glyphosate from use, the Maintenance Department's Vegetation Control Section has identified approximately 5 miles among 3 canal segments (+1% of all canals) to further its studies.

NID will expand upon previous studies and implement a mowing and natural growth program through the 2021-2022 growing season in an effort to limit the application of glyphosate. The Hemphill, Doty South, and Smith Gordon Canals will alternatively be maintained with a 4-foot flail mower and 3-point side trimmer towed by UTVs/ATVs, each mounted with 50-gallon fire suppression tanks. Staff will document the time required to maintain the vegetation along these canal berms and banks, and the mowing frequency required to keep vegetation close to 6-inches in height. Staff will further evaluate portions of these canals for the potential to leave banks and portions of the berms in a natural state. Evaluation criteria includes, but are not limited to, canal depth, canal shape, land use, canal access, and vegetation types. Natural state means that staff would use no means of controlling vegetation unless there is an impact to canal water flows.

Through the 2021-2022 growing season, the Maintenance Department's Vegetation Control Section is also committed to implementing vegetation management alternatives,

by rotating the “primary post-emergent herbicide” away from glyphosate-based products for the first time in over 20 years. Staff is implementing the use of Diquat Bromide, which is a contact kill herbicide that also has an Aquatic Use label. By alternating products, staff hopes to achieve a 30% reduction in glyphosate use for the current year.

Should the results of the removal of terrestrial herbicides this year prove successful, staff hopes to achieve herbicide-free canal berms and banks along the previously identified 5 miles of canal segments (+1% of all canals) by April 1, 2022, with the possibility of increasing these results by 1% to 2% per year over the next 5 years.

Based on the results of the Phase 3 Report and Blankinship study, staff is currently opting to not implement the use of organic herbicides, due to the unavailability of 2 of the top 3 acting herbicides (Opportune and Weed Slayer) and the third (Scythe) as not having Aquatic Use labeling. Other organic herbicides may be considered in the future, but due to increased application rates and much higher cost per acre products, further testing would need to be completed before integrating such into the District’s IVM Program.

A weed steamer unit showed some success during the previous trials. The unit appeared to successfully control weeds when used at the proper plant growth stage. Due to the heavy water usage and the unit’s estimated cost, it may not be viable for vegetation control on berms, but its use along canal banks may be applicable. Further testing of the unit’s capabilities would be required before implementing its use.

A weed blaster unit did not prove successful during the Phase 3 trials; however, the use of a heavily modified unit with aftermarket parts may have some viability. Due to the extreme amounts of gritty material required, the unit may not be viable for vegetation control on berms, but its use along canal banks may be applicable. Further testing of the unit’s capabilities would be required before implementing its use.

BUDGETARY IMPACT:
The 2021 Maintenance Budget includes $16,850.00 in 10192-52504 for materials and $245,000.00 in 10192-52501 for herbicides. Taking into account the effectiveness of alternative herbicides and mechanical vegetation control, as well as the lack of product accessibility, the following budgetary impacts should be considered:

- Vegetation target impact: 80% to 100% control

- Overall costs:
  - Equipment: $7,600.00 (included in 2021 budget)
  - Organic herbicides: $0.00
  - Alternative herbicide (Diquat Bromide): $0.00 (no increase per acre per application)
  - Labor: Unknown at this time - Higher demand on labor and canal monitoring will be offset by lower application frequency for the current year

- Mowing and weed whacking:
  - Increase to labor costs to be determined
  - Purchasing of additional equipment, based on current trials

- Steamer: Equipment not included in the 2021 budget - Staff currently working on equipment cost and viability

- Weed blaster (walnut shells): Based on NID trials, equipment designated by the Phase 3 study was not successful. Further research and trials would be needed to be considered viable.

/ram/jdc

Attachments (4):

- Study on Glyphosate Alternatives by Blankinship & Associates, Inc.
- Maps
- NID's Integrated Vegetation Management Program Phase 3 Report, as presented on July 28, 2020 to the Maintenance & Resource Management Committee
- PowerPoint Presentation "Study on Glyphosate Alternatives", prepared by Blankinship & Associates, Inc.

Study on Glyphosate Alternatives

March 10, 2021

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Nevada Irrigation District

Study on Glyphosate Alternatives

Grass Valley, California

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1. EXECUTIVE SUMMARY

The Nevada Irrigation District assessed alternatives to the popular and commonly used herbicide glyphosate, the active ingredient in Roundup® and other herbicide products. Based on its ease of use and cost-effectiveness, it is a popular tool for vegetation control. Adverse public sentiment regarding the safety of glyphosate and weeds developing resistance to glyphosate are reasons to consider alternatives.

Glyphosate alternatives, including other herbicides, physical/mechanical control methods, and grazing were assessed for cost and overall effectiveness. On average, alternative herbicides were found to be 3 and 13 times more cost-effective than grazing and physical/mechanical methods, respectively. Of herbicide types, conventional post-emergent herbicides such as glyphosate were found to be 4 and 18 times more cost-effective per acre than pre-emergent and organic post-emergent herbicides, respectively.

The top 10 highest ranked control tools include mulching, weed mats, solarization, grazing, steaming, hand removal, and 4 herbicide subcategories. Not all tools are applicable to all areas of the District's footprint. For example, tools such as mulching and weed mats are appropriate for landscaped areas near buildings but not along long linear canal rights-of-way. Although tools such as mowing and weed whacking were not identified in the top 10, they are still important tools for the District to use as appropriate.

Thirty public agencies who perform vegetation management were contacted of which 10 agreed to participate in a survey regarding impacts due to their discontinuation of glyphosate. Among the results were that 90% experienced increased cost and 70% reported decreased service levels.

Alternatives exist for glyphosate and in many cases, good reasons exist for their use. Trade-offs on cost, effectiveness, safety and public perception need to be balanced when considering and selecting alternatives.

2. INTRODUCTION

Nevada Irrigation District (NID) is a California Special District that provides water service to over 25,000 homes, businesses and farms throughout a 450 square-mile service area within portions of Nevada, Placer, and Yuba Counties. NID provides raw water, primarily for agricultural irrigation, and treated potable water for domestic, commercial, municipal, and industrial needs. NID also produces hydroelectric energy and provides recreational services.

The NID water supply originates from natural runoff from over 70,000 acres located in high mountain watersheds in the Sierra Nevada Mountains. NID owns and operates 10 major and 17 minor reservoirs, more than 475 miles of canals, 6 water treatment plants, 13 water systems, and over 400 miles of treated water pipelines. The NID water system serves approximately 19,000 treated water customers and 6,000 raw water customers.

The District's overarching mission is to provide a dependable, quality water supply and continue to be good stewards of the watersheds, while conserving the available resources in its care.

2.1. NID Integrated Vegetation Management Program

Integrated Pest Management (IPM) is defined by the University of California Statewide Agricultural and Natural Resources Program as an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment.

Integrated Vegetation Management (IVM) is a subcategory of IPM which focuses on the control of plant pests and their damage.

In an effort to deliver reliable and low-cost water to customers, the District's Integrated Vegetation Management (IVM) Program incorporates the use of biological, chemical, cultural and mechanical treatments to control vegetation growth in and around District infrastructure. Unmanaged vegetation in and around District facilities can impede water flow, choke off canals, reduce water storage capacity, contribute to wildfire hazards, and impact water quality and public health. The District IVM Program is a critical element of the District and supports dependable water for human consumption, irrigation, and fire suppression.

The District IVM Program aims to continue implementation of adaptive management techniques that are environmentally sound, effective, efficient, fiscally prudent, and compliant with regulatory requirements. In researching new and innovative vegetation control methods to add to its IVM Program, District efforts have included trial studies with UC Davis researchers using acetic acid (vinegar), barley straw and corn gluten, thermal steaming, burning, tarping, grazing, and organic herbicide testing.

In 2017, the District applied for a California Department of Pesticide Regulation (DPR) Research Program Grant to support a field study aimed at identifying effective glyphosate alternatives. As part of the grant application development, the District designed a pilot study to field test organic chemical, biological and mechanical treatment methods. The study design included application,

data collection, and data analysis regarding the efficacy and costs of each method, with a goal of developing a comprehensive IVM program to guide terrestrial vegetation management. Although the grant was not awarded, the process of developing the application helped the District to establish the IVM team and catalyzed the field study efforts. As a result, the District opted to move forward with a scaled-down version of the field study.

Phase 1 of the field study evaluated the effectiveness of mowing, an abrasion weeder, goat grazing, and 9 organic herbicides (i.e., A.D.I.O.S., Axxe, Avenger Concentrate, Weed-A-Way, Weed Zap, Finalsan, Suppress EC, Opportune, Marrone). Based on the results of Phase 1 field testing, trials of the 5 organic herbicides that produced the greatest measurable results were expanded in Phase 2 (i.e., Axxe, Avenger Concentrate, Finalsan, Suppress EC, Opportune), as well as trials for weed whacking and abrasion weeding. Phase 2 also tested the effectiveness of 3 new organic herbicides (i.e., Scythe, Weed Slayer, Phydura), steaming, burning, and native plant installations. The 3 top performing herbicides identified in Phase 2 (i.e., Opportune, Scythe, Weed Slayer) were tested in Phase 3 of the field study across a larger application area. Based on the Phase 3 results, it was recommended that the District maintain its research and investigation efforts in identifying and testing alternative vegetation control methods, including studying the use of Weed Slayer and Scythe under a protocol with increased application frequency to investigate the ability and resources necessary to achieve a level of weed control supportive of water quality and health, reliable delivery to customers, employee safety and wildfire prevention.

2.2. Study Purpose

With a general increasing trend of resistance to glyphosate in both public perception and plants, the District is mindful that an adaptive IVM Program is vital to continue safe and reliable delivery of water to its customers. The purpose of this study is to identify and evaluate available glyphosate alternatives and the costs associated with deployment of those alternatives. Information learned throughout the course of the study will be used to support an adaptive and effective IVM Program, including necessary planning, budgeting, and implementation.

3. EVALUATION OF GLYPHOSATE ALTERNATIVES

Vegetation management may be conducted using a variety of tools. In IVM, a combination of tools is typically implemented to support effective and sustainable weed control. Vegetation management approaches generally fall into one of 4 IVM categories:

- ***Physical/mechanical control*** – practices that kill or damage a pest directly, physically block or prevent pest entry, or make the environment unsuitable for pests.
- ***Biological control*** – the use of natural enemies or other species to manage pests.
- ***Cultural control*** – preventative measures that discourage damaging pest populations from developing by reducing a pest's ability to establish, reproduce, disperse, and survive.
- ***Chemical control*** – the use of pesticides such as herbicides which are intended to kill, prevent, repel, or mitigate pests.

Examples of specific control tools within each of these categories are presented and described in **Table 1** below. Please note that cultural control tools have been included in the table for reference but were not included in the current study because they are generally considered to be preventative practices (e.g., rinsing tools and equipment of weed seeds and fragments to prevent spread to other sites) and are often most applicable to landscaped or vegetated sites (e.g., irrigation and nutrient management). Cultural controls may in other cases be described as deliberate modifications to physical/mechanical control strategies to improve the competitive ability of desirable plants (e.g., modifications to turf mowing height or frequency). While not designed to control weeds directly, cultural controls should be considered for use in combination with other control strategies when appropriate.

Table 1. Examples of IVM Control Tools

Category	Control Tool	Description
Physical/ Mechanical	Mowing/Weed Whacking	The use of flail, deck, hand mower, string trimmer or like devices to clear vegetation.
	Hand Removal	The physical pulling of weeds with and without manual equipment.
	Flaming	The use of a propane or butane torch to damage and ultimately kill weeds.
	Steaming	The use of heat from steam or boiling water to damage and ultimately kill weeds.
	Foaming	A variant of steaming involving the use of an adjuvant to produce hot foam which helps to extend the amount of time during which weeds are exposed to high heat.
	Mulching	The physical placement of mulch to limit light required for weed establishment.
	Soil Solarization	The heating of soil by covering it with plastic sheeting long enough to kill weed seeds and seedlings and prevent establishment.
	Weed Mats	The placement of landscape fabric to shade out weeds and create a physical barrier to discourage growth.

Category	Control Tool	Description
	Excavation	Mechanically removing weed(s) and underground structures using heavy equipment.
	Soil Tillage	The turning up and breaking of soil to uproot plants, exposing their roots and seeds.
	Prescribed burning	The deliberate, controlled burning of an area to control plants and/or reduce the seed bank.
Biological	Grazing	The use of goats, sheep, and other animals to eat plant material.
	Insects & Pathogens	The use of plant host-specific insects and microorganisms to control weeds.
Cultural	Irrigation Management	The selective timing, rate, volume, and location of water to favor desirable plants.
	Nutrient Management	The selective use of fertilizer types, placement location, timing, and amounts to support desirable plants and reduce weed pressure.
	Sanitation	The use of clean tools and materials to prevent the spread of weeds/seeds.
	Overseeding/Competitive Species	The distribution of seeds of planting of desirable species to outcompete weeds.
Chemical[1]	Pre-Emergent Herbicides	Systemic herbicides applied before weeds emerge to control seeds to discourage or eliminate future weed growth.
	Post-Emergent Herbicides	Contact or systemic herbicides applied after weeds emerge.
	Systemic Herbicides	Pre- or post-emergent herbicides that translocate from the site of application through the plant's vascular system and kill the entire plant.
	Contact Herbicides	Post-emergent herbicides that kill only the portion of weeds that they come in contact with.
	Conventional Herbicides	Pre- or post-emergent herbicides made from synthetic materials.
	Organic Herbicides	Contact herbicides, typically post-emergent, derived from naturally occurring materials.
	Broad-Spectrum Herbicides	Pre- or post-emergent herbicides that control most weeds to which they are applied.
	Selective Herbicides	Pre- or post-emergent, systemic herbicides that selectively kill certain types of weeds (e.g., monocots, dicots).

[1] Note that herbicides can be categorized in many ways (e.g., via application timing, translocation, source of ingredients, and selectivity) and typically fall into more than one category. For example, glyphosate is a conventional systemic herbicide which provides broad-spectrum, post-emergent control of vegetation.

3.1. Advantages and Disadvantages of IVM Tools

There are advantages and disadvantages associated with all vegetation management tools. Mowing, for example, is a common practice that allows for the temporary control of weeds without the use of herbicides; however, its fast-moving parts increase fire risks and the likelihood of debris being ricocheted and damaging nearby property. Goat grazing is often well received among members of the community and can be used in a variety of sites; however,

goats may damage desirable plants or distribute invasive weed seeds to other sites via their droppings. Organic herbicides tend to produce rapid results and break down quickly in the environment; however, they are often more acutely hazardous to applicators and require higher application rates and more frequent retreatments than conventional herbicides. Conventional herbicides such as glyphosate may provide greater and longer lasting weed control than non-chemical control tools; however, overreliance on specific herbicides or modes of action may contribute to or accelerate the development of resistance. Further discussion on herbicide resistance can be found in **Section 3.1.1**.

The advantages and disadvantages of various control tools described in **Table 1** are summarized in **Table 2** by assigning scores based on the following criteria: time and cost effectiveness; efficacy; longevity of control; worker, public, and environmental safety; fire safety; and public perception. Scores were assigned based on professional judgement of relative effectiveness compared to other control tools. Assignment of scores assumed control tools were properly implemented and appropriately timed.

The highest scoring tools included mulching, weed mats, pre-emergent herbicides, and post-emergent systemic herbicides, followed by soil solarization and grazing. It is important to note that despite these scores, not all control tools are feasible for widespread use on District sites such as across large areas or along canal banks. For example, mulching, weed mats, and soil solarization are generally better suited for small or landscaped areas. Other control tools must similarly be selected and used in a manner that is appropriate for the site and target level of control. Consideration must therefore be given to the suitability of control tool implementation on a case-by-case basis rather than solely relying on the scores provided in **Table 2**.

For additional information on the advantages and disadvantages of specific control tools, refer to **Appendix A**.

Table 2. Overview of Control Tool Advantages and Disadvantages

Control Category	Control Tool			Effectiveness Score[1]										
				Time Effectiveness[2]	Cost Effectiveness[3]	Efficacy[4]	Longevity of Control[5]	Worker Safety[6]	Public Safety[7]	Environmental Safety[8]	Fire Safety[9]	Public Perception[10]	Ease of Use[11]	Total
Physical/ Mechanical	Mulching			3	3	4	4	4	5	4	4	5	4	40
	Weed Mats			3	3	3	4	4	5	4	5	5	4	40
	Soil Solarization			1	3	4	3	4	5	4	5	4	3	36
	Hand Removal			1	1	4	2	2	5	4	5	5	1	30
	Excavation			2	1	3	3	3	4	3	4	3	2	28
	Soil Tillage			2	2	4	2	3	4	3	4	2	2	28
	Steaming			1	1	3	2	2	4	3	4	4	3	27
	Mowing			4	2	3	2	2	2	2	2	4	3	26
	Prescribed Burns			2	4	2	3	2	1	2	1	3	2	22
	Weed Whacking			2	1	3	2	1	2	2	2	4	2	21
	Flaming			1	2	3	2	1	2	2	1	3	2	19
Biological	Grazing			2	3	3	2	4	5	4	5	5	3	36
	Insect/Pathogen Biocontrol			1	1	1	1	5	5	5	5	3	1	28
Chemical	Pre-Emergent Herbicides			5	4	4	4	3	4	3	5	4	4	40
	Post-Emergent Herbicides	Systemic		5	5	4	5	3	3	3	5	3	4	40
		Contact	Conventional	4	3	4	3	3	3	3	5	3	4	35
			Organic	4	1	2	2	2	3	4	5	4	4	31

Relative Effectiveness Scoring System: **5** = Very High/Excellent, **4** = High/Good, **3** = Medium/Neutral/Highly Variable, **2** = Low/Fair, **1** = Very Low/Poor

Table 2 Notes:

[1] Control tools were scored based on professional judgement of relative effectiveness compared to other control tools. Assignment of scores assumed control tools were properly implemented and appropriately timed.

[2] Time effectiveness scores based on anticipated time to complete one treatment. Consideration also given to potential need for retreatments.

[3] Cost effectiveness scores based on anticipated cost per acre, with consideration given to costs associated with labor, equipment, and materials.

[4] Efficacy scores based on anticipated level of control achieved after one treatment, with consideration given to ability to reduce pest population size.

[5] Longevity of control scores based on length of time full or partial control is anticipated to last before another treatment is required.

[6] Worker safety scores based on potential risks to vegetation management workers while implementing control tools (e.g., repetitive motions; burns; slip, trip, and fall hazards; exposure to herbicides).

[7] Public safety scores based on potential risks to the general public as a result of vegetation management activities (e.g., property damage from ricocheting debris, respiratory irritation resulting from poor air quality when dust generated from mowing, weed whacking, burning, exposure to herbicides).

[8] Environmental safety scores based on potential environmental concerns as a result of vegetation management activities (e.g., air quality, water quality, risks to non-target organisms).

[9] Fire safety scores based on potential for unintentional ignition of target or non-target vegetation during the implementation of the control activity.

[10] Public perception scores very generally assigned based on likelihood of control tool implementation to result in public complaints.

[11] Ease of use scores based on anticipated difficulty of control tool implementation. Considers training and regulatory requirements, effort required to properly implement, unique equipment needs, general ease of use.

3.1.1. Note on the Development of Herbicide Resistance

An important factor in sustainable vegetation management is herbicide resistance management. Herbicide resistance describes the ability of a plant to survive and reproduce after exposure to a dose of herbicide that would normally be lethal to a non-resistant counterpart. In California, for example, 7 weed species are resistant to glyphosate including: palmer amaranth, hairy fleabane, horseweed, junglerice, Italian ryegrass, rigid ryegrass, and annual bluegrass.

Several factors influence the development of herbicide resistance in weeds. Some individuals of a pest population, for example, may be genetically predisposed to develop resistance. Biological factors such as the species' rate of seed production and germination also influence the rate of resistance development. Humans similarly play a role in herbicide resistance development. Repeated applications of the same herbicide, or herbicides with the same mode of action, over multiple generations of the pest life cycle can lead to resistance in a plant population, reducing the effectiveness of the herbicide. The use of products which act on a single target site within plant cells rather than having multiple target sites (i.e., products which have a single mode of action) may encourage the development of target-site resistance. Other examples of vegetation management practices that may increase the risk of resistance development are using less than the label rate and improperly timing of pesticide applications resulting in the need for more applications or higher application rates. Note that resistance development has also been observed in association with other pesticide classes such as rodenticides, insecticides, and fungicides and is similarly influenced by such factors.

Proactive herbicide resistance management includes rotating herbicides with different modes of action and always following label directions. Species showing signs of potential resistance development must be addressed promptly in order to maintain adequate control of target vegetation. For additional information on herbicide resistance management practices, refer to a University of California IPM Program weed specialist, a crop adviser, the U.S. Environmental Protection Agency (USEPA), or similar resource.

3.2. Cost Data

Data on the cost of labor, equipment, and materials per acre associated with implementing specific control tools was gathered others in the vegetation management profession and the open literature for comparison of the relative cost associated with implementing general control categories (i.e., physical/mechanical, biological, and chemical controls). This cost data is presented in **Appendix B** and summarized in **Table 3** below.

Table 3. Cost of Implementation of Various Control Categories Per Acre

	Cost of Implementation		
Control Category	Min	Max	Average
Biological	$171	$6,534	$1,323
Physical/Mechanical	$350	$50,809	$5,381
Chemical	$80	$1,731	$412

Overall, chemical control was found to be the most inexpensive control category on average while physical/mechanical control was the most costly category. Note that the cost data presented in this report are preliminary and may vary based on site-specific conditions. Actual vegetation management costs realized per acre will vary based on the combination of control tools implemented. In addition, data reflect the cost per acre per treatment for individual control tools or categories and do not include costs associated with any necessary retreatments, if any.

The only biological control tool for which cost data was obtained is goat grazing. Grazing costs often vary based on the nature of the grazing site and time of year (e.g., a higher cost may be incurred in the springtime when there is a high demand for grazing). The estimated cost per acre per treatment ranged from $171 to $6,534 with an average cost of $1,323 per acre. Based on this data, the implementation of biological controls is 3.2 times greater than the average cost of implementation of chemical controls.

Physical/mechanical tools for which cost data were available include: brushcutting, excavation, flaming, foaming, hand pulling, mowing, weed whacking, mulching, prescription burning, and steaming. Costs for implementing specific tools varied greatly based on factors such as the sensitivity and degree of site accessibility as well as inclusion of expenses associated with but not directly resulting from vegetation management (e.g., training, permits, and hauling debris to disposal sites). The estimated cost per acre per treatment ranged from $350 to $50,809 with an average cost of $5,381. Based on this data, the implementation of physical/mechanical controls is approximately 13 times greater than the average cost of implementation of chemical controls.

Excavation, brushcutting, and steaming were among the most expensive physical/mechanical tools, while mowing and prescription burning were among the least expensive. At least one data point each for manual brushcutting and back hoe excavation indicated that implementation of these tools would result in an estimated cost exceeding $20,000 per acre for sites with limited to no equipment accessibility. These high cost estimates reflect increased labor requirements to use manually operated tools, consideration of dense canal-side vegetation growth, and collection of cut vegetation for offsite disposal.

Labor, equipment and material cost for herbicide applications ranged from $80 to $1,731 per acre, with an average cost of $412 per acre. Where specified, most chemical cost data points were associated with the use of conventional herbicides; however, information on specific herbicides and application rates used was not always available. To address this data gap, data on the material cost per acre of specific herbicides was gathered (see **Appendix B**). Refer to **Table 4** below for an overview of this data.

Table 4. Material Cost of Various Herbicide Types Per Acre

	Cost		
Herbicide Type	Min	Max	Average
Pre-Emergent	$17	$456	$141
Post-Emergent (Conventional)	$13	$132	$33
Post-Emergent (Organic/Alternative)	$144	$1,664	$650

Conventional post-emergent herbicides were found to be the least expensive herbicide category while organic post-emergent herbicides were found to be the most expensive. For all herbicides,

costs per acre varied based on the market price for specific products as well as the application rates used. Note that **Appendix B** includes both broad spectrum and selective herbicides and that use of a selective herbicide may result in the need to tank mix products in order to obtain broad spectrum control.

Pre-emergent herbicides such as aminopyralid, dithiopyr, indaziflam, and oryzalin (example trade names include Milestone, Dimension, Specticle, and Surflan, respectively) ranged in cost from $17 (Milestone VM) to $456 (Freehand 1.75G) per acre, with an average cost of $141 per acre. Most pre-emergent herbicide cost data were based on applications made at the highest labeled rate. When specified, the application rates used to derive cost data ranged from 9 to 32 fluid ounces per acre (approximately 0.07 to 0.25 gallons per acre). Data on a single granular product (i.e., Freehand 1.75G) was also obtained and was cited as being applied at a rate of 120 pounds per acre. Based on this data, the use of pre-emergent herbicides is 4.2 times greater than the average cost of conventional post-emergent herbicide use and 8.3 times greater the average cost of glyphosate use; however, the annual cost of pre-emergent herbicide use per acre may be lower because only 1 to 2 applications are typically needed.

Conventional post-emergent herbicides such as clethodim, glufosinate, glyphosate, and triclopyr (example trade names include Grassout Max, Finale, Roundup, and Vastlan, respectively) ranged in cost from $13 (Grassout Max) to $132 (Clearcast) per acre, with an average cost of $33 per acre. Similar to data on pre-emergent herbicides, approximately half of the conventional post-emergent herbicides were cited as being applied at either the highest labeled rate or as a spray-to-wet application. When specified, the application rates used to derive cost data ranged from 32 to 192 fluid ounces per acre (approximately 0.25 to 1.5 gallons per acre). The average cost of glyphosate use in particular was $17 per acre, with specified application rates ranging from 72 to 120 fluid ounces per acre (approximately 0.56 to 0.94 gallons per acre).

Organic/alternative post-emergent herbicides such as acetic acid, ammonium nonanoate, clove oil, and d-limonene (example trade names include Nature's Wisdom, AXXE, Burnout, and Avenger, respectively) ranged in cost from $115 (Weed Slayer) to $1,664 (Avenger) per acre, with an average cost of $622 per acre. The application rates used to derive cost data, when specified, were highly variable and ranged from 5 to 30 gallons per acre. Based on this data, the use of organic/alternative post-emergent herbicides is 18.4 times greater than the average cost of conventional post-emergent herbicide use and 36.6 times greater than the average cost of glyphosate use; however, the average annual cost associated with organic/alternative herbicide use is expected to be higher due to the likelihood that multiple retreatments will be necessary.

On December 4, 2020, the California Department of Food and Agriculture (CDFA) issued a Stop Use Notice, Statewide Quarantine, and Removal of Sale Order for the product Agro Gold WS. Agro Gold WS is the second part of the two-part organic herbicide product Weed Slayer and was found to contain both glyphosate and diquat. At this time, the purchase and use of Agro Gold WS alone or as part of Weed Slayer is not permitted. When Weed Slayer datum is excluded from **Appendix B**, the organic/alternative herbicides range in cost from $144 to $1,664 per acre, with an average cost of $650 per acre. Read the Stop Use Notice here: https://www.cdfa.ca.gov/is/ffldrs/pdfs/SOP_Notice_to_Organic_Operations_Agro_Gold_WS_FINAL_20201204.pdf. The Statewide Quarantine and Removal of Sale Order can be found at: https://www.cdfa.ca.gov/is/ffldrs/pdfs/FFLDRS_Statewide_Agro_Gold_WS_Quarantine_Order_FINAL_20201204.pdf.

4. SURVEY OF ENTITIES REGARDING DISCONTINUATION OF GLYPHOSATE USE

A total of 30 entities that practice IVM were contacted to participate in a survey designed to gather information on the results, impacts, and overall experience of discontinuing the use of glyphosate. Of the 30 entities contacted, 10 agreed to participate in the survey. No irrigation districts were known to have discontinued glyphosate use at the time of the survey; therefore, irrigation districts could not be included. The name of each entity surveyed and the site types for which its survey responses are relevant to are presented in **Table 5** below.

Table 5. Entities Surveyed and Applicable Site Types

Entity	Applicable Site Types
City of Burbank	Parks, including some undeveloped areas
City of Carlsbad	Parks, trails, open space, medians, parkways
City of Healdsburg	Parks, open space, trails
City of Richmond	Parks, rights-of-way, medians
City of Santa Cruz	Watershed land, including access roads and trails
City of Watsonville	Trails, open space, rights-of-way, alleyways, levees, parking lots
Marin Municipal Water District	Watershed land, including access roads and trails
San Lorenzo Valley Water District	Watershed land, including sensitive species habitat
Town of Windsor	Facilities, parks, streetscapes, rights-of-way, medians
University of California, Davis	Riparian restoration area, including trails

Of the participating entities, 6 entities specifically discontinued use of glyphosate in one or more management areas, while 2 entities discontinued use of all synthetic pesticides and 2 entities discontinued use of pesticides altogether. In most cases, these changes in herbicide use practices were the result of public concern based on the perceived risk of glyphosate and/or general pesticide use and the subsequent rule-making action taken by the entities' Council or Board. A discussion on the perception of risk is included in **Section 4.1**.

When asked which herbicides, if any, were currently being used in lieu of glyphosate, 2 entities reported using pre-emergent herbicides. Both entities also currently use post-emergent contact herbicides, with one entity utilizing conventional herbicides and the other organic herbicides. Two entities reported using solely organic herbicides since discontinuing glyphosate use. Only one entity reported switching to an alternative conventional post-emergent systemic herbicide. The remaining 5 entities currently do not use any herbicides as glyphosate alternatives.

Examples of pre-emergent herbicides currently used in lieu of glyphosate include dithiopyr (example trade name: Dimension 2EW) and isoxaben (example trade name: Gallery 200SC). Examples of conventional post-emergent herbicides include the contact herbicide glufosinate (example trade name: Forfeit 280) and the systemic herbicide imazapyr (example trade name: Habitat). Examples of organic herbicides include: ammonium nonanoate (example trade name: Axxe), pelargonic acid and related fatty acids (example trade name: Scythe), caprylic and capric acids (example trade name: Fireworxx), clove and cinnamon oils (Weed Zap), and peppermint oil, potassium sorbate, and sodium chloride (Whack Out Weeds).

Glyphosate Discontinuation Survey Key Takeaways:

% of Respondents Who Answered Yes Responses

Decrease in service levels

70%

Increased cost of vegetation management activities

90%

Not currently using any herbicides

50%

Increased implementation of physical/mechanical controls

100%

For all entities, the increased weed pressure resulting from the discontinuation of herbicide use for these entities translated to increased resources spent on implementing physical/mechanical controls such as mowing, weed whacking, and hand pulling.

Following the discontinuation of glyphosate use, 7 out of 10 entities reported a reduction in service levels compared to when glyphosate was used as a tool for vegetation management, particularly during periods of high weed growth. The decrease in service levels was primarily attributed to limitations on available labor hours and funding needed to maintain a level of control consistent with the level of control achieved prior to the discontinuation of glyphosate use. The cost of performing vegetation management increased for most entities and ranged from minimal or moderate to orders of magnitude. Large increases in annual vegetation management expenses were generally associated with greater labor hours being spent implementing physical/mechanical controls more frequently and widely, and/or the purchase and use of organic herbicides.

In some instances, impacts to service levels were buffered in ways other than increasing implementation of physical/mechanical controls and/or use of alternative herbicides. The Marin Municipal Water District, for example, noted having a robust invasive weed management program utilizing plant mapping tools and an Early Detection Rapid Response approach established prior to discontinuing glyphosate use. In another example, the City of Burbank representative emphasized the importance of public education to communicate the need for stakeholders to adjust their tolerance for weeds and service level expectations in acknowledgement of the limitations on the effectiveness of vegetation management efforts without the continued use of conventional post-emergent herbicides such as glyphosate.

To learn more about the information learned from each entity, including examples of specific control tools tested but not ultimately adopted for ongoing use, refer to **Appendix C**.

4.1. Note on the Perception of Risk

There is often public concern over the risks that herbicide or pesticide use may cause to humans and the environment. It is important to acknowledge that all chemicals, including herbicides, have the potential to be hazardous. However, the risk of experiencing adverse impacts from a chemical can only be estimated by relating the chemical hazard, or toxicity, to the degree of an individual's exposure to that chemical. Even chemicals which are low in toxicity

can pose a risk if the exposure is high enough. Likewise, chemicals that are high in toxicity can be used relatively safely if the exposure is low. Simply put, without both toxicity and exposure, there is no risk. This relationship is often expressed as follows:

Risk = Toxicity x Exposure

Toxicity is an inherent quality of a chemical which describes the amount of a chemical that will produce an adverse effect. The U.S. Environmental Protection Agency (USEPA) uses four toxicity categories to describe the acute toxicity of pesticides. The acute toxicity of registered pesticides is then expressed as a "signal word" on associated product labels. Refer to **Table 6** below for a summary of USEPA's toxicity categories and associated signal words.

Table 6. USEPA Pesticide Toxicity Categories

Toxicity Category	Description	Signal Word
Category I	High toxicity	DANGER or DANGER-POISON
Category II	Moderate toxicity	WARNING
Category III	Low toxicity	CAUTION
Category IV	Very low toxicity	CAUTION (optional)

In contrast to toxicity, risk describes the likelihood that a chemical will produce an adverse effect under a given exposure scenario. This likelihood is based on factors such as which herbicide is used and at what concentration, the quantity of herbicide applied, the formulation used, environmental conditions, how often the herbicide is applied and over what period of time, and the manner in which an individual has contact with it.

In order for an herbicide to produce an adverse effect, an individual must be exposed. Exposure can occur in the following ways:

- Ingestion (e.g., residues in food or water)
- Inhalation (e.g., vapors, droplets, or dust)
- Dermal contact (e.g., getting it on your skin or in your eyes)

An important factor determining exposure is the amount of herbicide that actually enters, or is absorbed by, the body. The ability for absorption varies based on the herbicide and the route of exposure. The time of exposure also influences the potential for pesticide absorption. For example, an herbicide touched shortly after it has been applied to a plant surface has a greater potential for absorption than one touched after it has dried. Once liquid herbicide residues have dried, transfer to human skin or other surfaces is generally minimal.

Based on the understanding that risk is a function of both toxicity and exposure, all conventional herbicides and their labels are subject to a rigorous evaluation and review process by USEPA and DPR before they are permitted for sale and use in California. Directions, precautions, and use restrictions on product labels are based on extensive research studies conducted to quantify toxicity to mammals, honeybees, fish, birds, and invertebrates and identify potential impacts to the environment. Label language developed as a result of such studies is intended to keep exposure below levels that would potentially result in unacceptable risk.

5. CLOSING REMARKS

NID takes an IVM approach to managing vegetation in and around District facilities to support its mission of providing a dependable, quality water supply and acting as good stewards of local watersheds, while conserving the available resources in its care. IVM involves implementing a combination of physical/mechanical, biological, cultural, and chemical tools to manage weeds in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment.

The selection of individual IVM tools requires consideration of the advantages and disadvantages of each tool relative to the settings in which they are being used, the species being managed, and the expected outcomes of management activities. Given that the majority of District terrestrial vegetation management sites abut long and linear canals, some control tools discussed in this report are not expected to be suitable or feasible for widespread use in such sites. Examples of such control tools include: mulch, weed mats, soil solarization, insect/pathogen biocontrol, organic herbicide application, soil tillage, prescribed burns, and hand removal. Similarly, having limited to no site accessibility to accommodate large equipment in some sites may preclude the use of tools such as excavators and lend to the need for more manual labor and the use of tools which may be less time and cost efficient.

In terms of cost, physical/mechanical controls were found to be associated with the highest average cost per acre, followed by biological controls and chemical controls. Among the chemical controls, the average material cost of organic herbicides per acre was found to be over 4 times greater than that of pre-emergent herbicides and nearly 19 times greater than that of conventional post-emergent herbicides such as glyphosate. Most entities surveyed regarding their experience following the discontinuation of glyphosate acknowledged that they had not yet found an individual vegetation management tool that was capable of being used as a replacement for glyphosate.

The results of this study emphasize the importance of taking an integrated approach to vegetation management and avoiding the overreliance on any single tool. Furthermore, if the complete exclusion of a specific tool from a vegetation management program is being considered, it should be done with caution and with careful consideration given to the known or anticipated benefits and drawbacks of such a decision, especially for tools that have shown to be important for managing critical pests.

Based on this study, it is recommended that the District maintain as many tools in its IVM toolbox as possible to support an adaptive framework in which management tools can be used safely, effectively, and strategically to carry out its mission of providing a quality water supply and practicing environmental stewardship. At this time, pursuing the use of Weed Slayer as a glyphosate alternative is not recommended. When implementing any control tool, always be aware of and act in compliance with applicable laws and regulations. When monitoring shows that herbicide use is needed, always read and product follow label instructions.

APPENDIX A

Advantages and Disadvantages of Various IVM Control Tools

Appendix A. Advantages and Disadvantages of Various IVM Control Tools

Control Category	Control Tool	Advantages	Disadvantages
Physical/ Mechanical	Mowing/Weed Whacking	• Instantaneous results • Aesthetically pleasing • No soil disturbance • Reduces fuel load • Can be effective and inexpensive, depending on equipment/landscape/site • Minimal training required • Longer duration of control when soil moisture is low • Controls all weeds that can be cut	• Timing is important to prevent weeds from going to seed • Not intended to kill vegetation • Access challenges if soil is too wet, banks are steep, etc. • Expensive, depending on equipment and landscape/site • Can be labor intensive • May need to clean-up trimmings at sensitive sites • Can directly harm wildlife • Possible risk of fire and/or property damage from rock or metal object collisions • Noise generating activity • Can spread weed seeds and soil-borne pathogens
	Hand Removal	• Good for landscaped areas • Highly selective for undesirable weeds • Instantaneous results • Generally safe for workers, the public, and environment • Effective at removing new/small infestations • Good public perception • Minimal training • Useful where inaccessible to some mechanical methods • Amenable to use of volunteer labor	• Likely of limited use to long linear ROWs like at NID • Labor intensive, costly • Frequent retreatment interval depending on target weed • Fragmentation may decrease effectiveness • Workers might accidentally harm/remove desirable plants • Impractical over larger areas or for significant infestations • Poor timing results in ineffective control if seeds have set • Potential risk to workers working near roadways/canals • Hand tools can spread weed seeds and soil-borne pathogens
	Flaming	• Fast acting • Effective on small annuals and young woody plants • Selectively targets undesirable weeds • Avoids soil disturbance	• Fire hazard potential • Potential risk of injury to workers • May require coordination with local fire department or CalFire • More expensive than some chemical methods • Not effective on established perennial plants • Only targets aboveground plant parts • Amount of time required to control each plant • Non-target plants can be injured • Air pollution

Control Category	Control Tool	Advantages	Disadvantages
	Steaming	• Fast acting • Effective on young plants • Selectively targets areas with undesirable weeds • No soil disturbance • Can damage both aboveground plant parts and root systems • Added foam can enhance heat conductance and make treatments more effective	• Does not control mature annuals, or tall grasses • Not effective on established perennial plants • Can be costly due initial equipment and maintenance costs • Significant time may be required to control each plant • Potential burn risk for workers, requiring PPE • Non-target plants can be injured • Requires a truck, fuel • Appearance/run-off of foam may cause aesthetic/water quality impacts
	Mulching	• Good for landscaped areas • Reduced soil erosion • Minimizes soil available for germination of undesirable plants • Can be applied to a variety of sites • Effective on annual weeds • May use recycled organic or inorganic materials (e.g., tires, wood chips) • Aesthetically pleasing • Mulch can add nutrients beneficial to certain desirable plants • Helps to conserve soil moisture • Increased effectiveness when layered over weed mats	• Likely of limited use to long linear ROWs like at NID • Timing sensitive • Organic materials may be potential fire risk • Labor costs and materials for installation can be expensive • Must clear existing weeds from site before placing mulch • Not suitable for use on sloped sites like canal banks • May not control perennials • If improperly placed, mulch can clog drains and conveyances • Some mulch materials may contain weed seeds • Damp soil may support other pests like snails or insects, or plant pathogens for landscape plants • Requires inspection to confirm depth of mulch is suppressing weed growth • Requires replacement every few years

Control Category	Control Tool	Advantages	Disadvantages
	Soil Solarization	• Good for landscaped areas • Can control weed seeds up to 6 inches deep • Safe to public • May kill plant pathogens • Can enhance soil nutrient content through breakdown of organic materials • No fire risk	• Likely of limited use to long linear ROWs like at NID • Takes time for desirable effects to be expressed (weeks) • Specialized UV-resistant material not always readily available • Non-specific control may impact beneficial plant and insect species • Specific timing requirements (hottest weeks of the year) • May be less effective on sandy soils that drain fast • May not be aesthetically pleasing • Should be used with caution upslope of areas at risk of soil erosion due to increased runoff potential • Site preparation recommended for increased effectiveness (i.e., bare soil, recently irrigated)
	Weed Mats	• Good for landscaped areas • Long duration of control • Little maintenance after installation • May be cost effective over time • Fire resistant materials available • Conforms to desired shape • Helps to conserve soil moisture and maintain uniform soil temperature • Increased effectiveness when layered under mulch	• High initial cost • Likely of limited use to long linear ROWs like at NID • Requires labor for site prep and installation • Mats vary in thickness and durability • May require replacement within several years, resulting in reinstallation costs and contributing to landfill load
	Excavation	• Can be used to remove large or established plants • Can remove root systems of perennials • Safe to public	• Soil disturbance may support new weed invasions • Erosion potential • Requires restoration of sites if soil disturbance is significant • Expensive • Labor intensive • Noise generating and ground disturbing activity • May promote spreading of weeds and soil-borne pathogens through contamination of equipment and fragmenting underground vegetative structures

Control Category	Control Tool	Advantages	Disadvantages
	Soil Tillage	• Can be relatively inexpensive • Quick • With proper timing and repeat tilling, can be effective against perennial plants • Safe to public	• May promote spreading of weeds and soil-borne pathogens through contamination of equipment, fragmenting underground vegetative structures, and surfacing buried seeds • Soil disturbance may support new weed development • Erosion and dust generation potential • Limited to areas that can accommodate motorized equipment • Requires training and skilled labor • Noise generating and ground disturbing activity
	Prescribed Burns	• Fast acting • Maybe effective over large area • Indiscriminate plant control (when desired) • Removes biomass that contributes to wildfire fuel loads • Can be used to support restoration of natural ecosystems	• Timing is important to prevent weeds from going to seed • Potential risk for accidental fire • Desirable plants can be injured if present in burn area • Permits and approvals required, e.g. local fire department or CalFire • Can stimulate germination of both invasive and desirable plant seeds • Air quality concerns • Ineffective against some species
Biological	Grazing	• Good public perception • May reach areas impractical for physical or mechanical methods • Can provide control of annual plants and to suppress seed production • May be inexpensive per acre if not used during peak grazing season • May generate revenue	• Expensive during peak grazing season • Timing important to prevent weeds from going to seed • Does not kill roots • Animal waste may promote bacteria presence and impact water quality • Can cause or contribute to erosion • Animals need to be protected from predators • Animals may have dietary preferences • Risk of animal escape, possibly resulting in safety issues • Limited to areas that can accommodate animals • Indiscriminate consumption may remove desirable vegetation • May inadvertently spread undesirable seeds

Control Category	Control Tool	Advantages	Disadvantages
	Insect and Pathogen Biocontrol	• Good public perception • Targets specific weed species	• Very weed-specific and therefore limited applicability • Long term strategy with time lag from deployment to target pest injury • Control generally limited to suppression, not eradication • Can become pests themselves • Pathogens are regulated as pesticides
Chemical	Pre-Emergent Herbicides	• Broadcast applications prevent seed germination over large areas effectively • Effective on a broad spectrum of target weeds, depending on product(s) applied • Often have label signal word of lowest concern • Preventative • Control weeds at most vulnerable life stage • Seedbank management supports long-term reduction in target weed populations • Effective applications may result in residual control that reduces the amount of post-emergent herbicides needed later in the season	• Not effective against existing, growing weeds • Limited window to apply • May not be labeled for use in aquatic sites • Generally more expensive than post-emergent herbicides • Requires rainfall or irrigation to activate • May be prone to photodegradation if not rained in/activated • Not effective on weeds that rely on vegetative reproduction • Due to potential groundwater quality concerns, some cannot be applied near wells
	Post-Emergent Herbicides	Post-Emergent (All types): • Greater flexibility in timing of applications compared to pre-emergent herbicides • Generally more time efficient than other control methods per unit area • Effective on a broad spectrum of target weeds, depending on product(s) applied Post-Emergent Systemic: • Generally less expensive than pre-emergent and organic herbicides • Less need to reapply than contact herbicides • Can kill the entire plant, including root system, resulting in lasting control • Often more effective on perennial weeds than contact herbicides	Post-Emergent Systemic: • Variable public perception • Potential for resistance development • May take days to weeks from application to see effects • Less effective when weeds are not actively growing or are mature • Accidental overspray or drift can damage or kill non-target plants Post-Emergent Contact (General & Conventional): • Unlikely to result in long-term control of established perennials • Often do not kill the whole plant Post-Emergent Contact (Organic): • Typically more expensive per unit volume than synthetic alternatives • Higher application rates required than for conventional herbicides • More frequent reapplication typically required to maintain control

Control Category	Control Tool	Advantages	Disadvantages
		• Can offer broad-spectrum or selective control depending on the active ingredient Post-Emergent Contact (All types): • Can be used selectively to kill only the non-woody plant parts on which they are applied Post-Emergent Contact (Conventional): • Generally less expensive than pre-emergent and organic herbicides • Can be used on larger plants with greater success than organic herbicides Post-Emergent Contact (Organic): • Good public perception • Naturally derived materials generally break down quickly in the environment • Visible effects quick (hours to days) • Effective broad-spectrum control of small plants	• Often less effective than synthetic alternatives • Can be more acutely toxic than synthetic herbicides (higher signal word, increased PPE) • Due to registration exemptions, there is often little environmental and toxicity data for risk assessment or Proposition 65 evaluation • Not typically labeled for use in aquatic sites • Timing is important (i.e., warm weather better) • Less effective on mature plants and grasses • Labels of products that are exempt from registration have not been reviewed by USEPA or DPR and may be significantly less detailed • Products that are exempt from registration not usually tested for efficacy

Notes:

1. Data sources include the Southern California Coastal Water Research Project's 2020 Technical Committee Report on Alternatives to Glyphosate for Vegetation Management in Los Angeles County, the University of California Statewide Integrated Pest Management program, and professional judgement.
2. The need to check for the presence of listed species or their habitat is applicable to all control tools listed above.
3. Use of herbicides requires appropriate training, the use of calibrated equipment, spill control and PPE, and the need to read and follow label instructions.

APPENDIX B

IVM Cost Data

Appendix B. IVM Cost Data

Table 1. Estimated Cost per Acre for Various Terrestrial Vegetation Control Methods

Organization[1]	Year	Control Category: Biological	Control Category: Physical/ Mechanical	Control Category: Chemical	Control Tool	Estimated Cost/Acre[2]	Notes	Reference
ACPWA	2018	✓			Goat grazing	$680		[1]
Contra Costa County	2012	✓			Goat grazing (peak and off season)	$1,108		[2]
Contra Costa County	2013	✓			Goat grazing (peak season)	$1,094		[4]
Contra Costa County	2013	✓			Goat grazing (off season)	$230		[4]
Contra Costa County	2014	✓			Goat grazing (peak season)	$854		[4]
Contra Costa County	2014	✓			Goat grazing (off season)	$171		[4]
Contra Costa County	2015	✓			Goat grazing (peak season)	$954		[5]
Contra Costa County	2015	✓			Goat grazing (off season)	$292		[4]
Contra Costa County	2016	✓			Goat grazing (peak and off season)	$404		[6]
Contra Costa County	2017	✓			Goat grazing (peak and off season)	$948		[7]
Contra Costa County	2018	✓			Goat grazing (peak and off season)	$920		[8]
Integrazers	2020	✓			Goat grazing	$300	3	[12]
MMWD	2006	✓			Goat grazing	$975		[10]
NID	2017	✓			Goat grazing	$6,534	4	[13]
SFEI	2006	✓			Goat grazing	$4,380		[9]
SFEI	2006		✓		Brushcutting	$50,809	5	[9]
MMWD	2006		✓		Brushcutting	$500		[10]
NID	2017		✓		Excavation (conventional)	$8,515	6	[13]
NID	2017		✓		Excavation (back hoe)	$38,458	7	[13]
SFEI	2006		✓		Excavation (back hoe)	$5,293		[9]
MMWD	2006		✓		Flaming	$1,975		[10]
MMWD	2006		✓		Foaming	$3,550		[10]
City of Watsonville	2018		✓		Hand pulling	$525	8	[14]
MMWD	2006		✓		Hand pulling	$2,400		[10]
Contra Costa County	2012		✓		Mowing	$745	9	[2]
Contra Costa County	2013		✓		Mowing	$762	9	[3]
Contra Costa County	2014		✓		Mowing	$828	9	[4]
Contra Costa County	2015		✓		Mowing	$1,445	9	[5]
Contra Costa County	2016		✓		Mowing	$2,342	9	[6]
Contra Costa County	2017		✓		Mowing	$822	9	[7]
Contra Costa County	2018		✓		Mowing	$415	9	[8]
MMWD	2006		✓		Mowing	$350		[10]
Santa Clara County Roads	2010		✓		Mowing	$822		[11]
ACPWA	2018		✓		Mowing (boom)	$3,175		[1]
Contra Costa County	2013		✓		Mowing (manual)	$1,666	9	[3]
City of Watsonville	2018		✓		Mowing/weed whacking	$822	8	[14]
PCWA	2019		✓		Weed whacking	$4,120		[14]
Town of Windsor	2018		✓		Weed whacking, mulching, and hand pulling	$486	10	[15]
Contra Costa County	2012		✓		Mulching	$2,042	9	[2]
Contra Costa County	2013		✓		Mulching	$3,729	9	[3]
Contra Costa County	2014		✓		Mulching	$3,495	9	[4]
Contra Costa County	2015		✓		Mulching	$4,482	9	[5]
Contra Costa County	2016		✓		Mulching	$9,338	9	[6]
MMWD	2006		✓		Mulching	$475		[10]

Table 1. Estimated Cost per Acre for Various Terrestrial Vegetation Control Methods

Organization[1]	Year	Control Category			Control Tool	Estimated Cost/Acre[2]	Notes	Reference
		Biological	Physical/ Mechanical	Chemical				
MMWD	2006		✓		Prescription burning (conventional)	$1,500		[10]
MMWD	2006		✓		Prescription burning (Terra Torch)	$725		[10]
NID	2017		✓		Steaming	$15,597		[13]
ACPWA	2018			✓	Post-emergent herbicides (unspecified) - Roads	$306		[1]
ACPWA	2018			✓	Post-emergent herbicides (unspecified) - Flood control channels and facilities	$395		[1]
City of Watsonville	2018			✓	Post-emergent herbicide (glyphosate)	$91	11	[14]
City of Watsonville	2018			✓	Post-emergent herbicide (glufosinate)	$147	12	[14]
City of Watsonville	2018			✓	Post-emergent herbicide (pelargonic acid and related fatty acids)	$1,384	13	[14]
City of Watsonville	2018			✓	Post-emergent herbicide (d-limonene)	$1,731	14	[14]
City of Watsonville	2018			✓	Pre-emergent herbicide (isoxaben)	$249	15	[14]
City of Watsonville	2018			✓	Pre-emergent herbicide (dithiopyr)	$126	16	[14]
City of Watsonville	2018			✓	Pre-emergent herbicide (indaziflam)	$184	17	[14]
Contra Costa County	2012			✓	Herbicides (unspecified) - Flood control access roads	$124	9	[2]
Contra Costa County	2013			✓	Herbicides (unspecified) - Flood control access roads	$240	9	[3]
Contra Costa County	2014			✓	Herbicides (unspecified) - Flood control access roads	$291	9	[4]
Contra Costa County	2015			✓	Herbicides (unspecified) - Flood control access roads	$319	9	[5]
Contra Costa County	2016			✓	Herbicides (unspecified) - Flood control access roads	$252	9	[6]
Contra Costa County	2017			✓	Herbicides (unspecified) - Flood control access roads	$479	9	[7]
Contra Costa County	2018			✓	Herbicides (unspecified) - Flood control access roads	$1,253	9	[8]
Contra Costa County	2012			✓	Herbicides (unspecified) - Flood control banks	$165	9	[2]
Contra Costa County	2013			✓	Herbicides (unspecified) - Flood control banks	$176	9	[3]
Contra Costa County	2014			✓	Herbicides (unspecified) - Flood control banks	$523	9	[4]
Contra Costa County	2015			✓	Herbicides (unspecified) - Flood control banks	$222	9	[5]
Contra Costa County	2016			✓	Herbicides (unspecified) - Flood control banks	$215	9	[6]
Contra Costa County	2017			✓	Herbicides (unspecified) - Flood control banks	$1,303	9	[7]
Contra Costa County	2018			✓	Herbicides (unspecified) - Flood control banks	$1,269	9	[8]
Contra Costa County	2012			✓	Herbicides (unspecified) - Roads	$142	9	[2]
Contra Costa County	2013			✓	Herbicides (unspecified) - Roads	$165	9	[3]
Contra Costa County	2014			✓	Herbicides (unspecified) - Roads	$150	9	[4]
Contra Costa County	2015			✓	Herbicides (unspecified) - Roads	$161	9	[5]
Contra Costa County	2016			✓	Herbicides (unspecified) - Roads	$159	9	[6]
Contra Costa County	2017			✓	Herbicides (unspecified) - Roads	$276	9	[7]
Contra Costa County	2018			✓	Herbicides (unspecified) - Roads	$665	9	[8]
MMWD	2006			✓	Post-emergent herbicides (unspecified)	$750		[10]
NID	2017			✓	Post-emergent herbicides (glyphosate and surfactant)	$361	18	[13]
PCWA	2019			✓	Post-emergent herbicides (glyphosate and surfactant)	$80	18	[14]
PCWA	2019			✓	Post-emergent herbicides (glyphosate, triclopyr, and surfactant)	$86	11,19	[14]
PCWA	2019			✓	Post-emergent herbicides (imazamox and surfactant)	$217	20	[14]
NID	2017			✓	Pre-emergent herbicides (flumioxazin and adjuvant)	$410	21	[13]
NID	2017			✓	Pre-emergent herbicides (isoxaben, dithiopyr, and adjuvant)	$569	16,22	[13]
PCWA	2019			✓	Pre- and post-emergent herbicides (aminopyralid, dithiopyr, glyphosate, and surfactant)	$147	11,23	[14]

Table 1. Estimated Cost per Acre for Various Terrestrial Vegetation Control Methods

Organization[1]	Year	Control Category: Biological	Control Category: Physical/ Mechanical	Control Category: Chemical	Control Tool	Estimated Cost/Acre[2]	Notes	Reference
Santa Clara County Roads	2010			✓	Pre- and post-emergent herbicides (dithiopyr, aminopyralid, glyphosate, and surfactant)	$275	16,24	[11]

Table 1 Notes:

[1] Abbreviations: Alameda County Public Works Agency (ACPWA), Marin Municipal Water District (MMWD), Nevada Irrigation District (NID), Placer County Water Agency (PCWA), San Francisco Estuary Institute (SFEI)

[2] Cost assumes 1 treatment per year and includes labor, equipment, and materials.

[3] Generally ranges $200 - $400 per acre.

[4] Ranges $871 - $8,712 per acre.

[5] Cost is reflective of the very labor-intensive nature of the project, which took place in the San Francisco Bay-Delta region in an area with limited equipment accessibility. Work required dense cattail and bulrush vegetation to be cut at the base, loaded onto cranes, transferred to a truck, and hauled to a disposal site. Disposal fees not included.

[6] Cost estimated for irrigation canal with a wide berm and equipment accessibility.

[7] Cost estimated for irrigation canal with a narrow berm and no equipment accessibility.

[8] Based on industry standard rates for labor and equipment.

[9] Cost includes overhead expenses (e.g., training, permits, habitat assessment).

[10] The cost of using weed whacking, mulching, and hand pulling in combination with glyphosate use was reported to be approximately $57.

[11] Example trade name: Roundup PROMAX.

[12] Example trade name: Finale.

[13] Example trade name: Scythe.

[14] Example trade name: Avenger.

[15] Example trade name: Gallery SC.

[16] Example trade name: Dimension (unspecified).

[17] Example trade name: Specticle Flo.

[18] Example trade name: Roundup Custom.

[19] Example trade name: Vastlan.

[20] Example trade name: Clearcast

[21] Example trade name: Payload.

[22] Example trade name: Gallery (unspecified).

[23] Example trade names: Milestone VM, Dimension 2EW.

[24] Example trade names: Milestone (unspecified), Roundup (unspecified).

Table 1 References:

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[5] Contra Costa County. 2016. Contra Costa County Integrated Pest Management Advisory Committee 2016 Annual IPM Program Status Report to the Transportation, Water, and Infrastructure Committee of the Contra Costa Board of Supervisors. Available: https://cchealth.org/ipm/pdf/2016-ipm-annual-report.pdf (Accessed: January 14, 2021).

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[7] Contra Costa County. 2018. Contra Costa County Integrated Pest Management Advisory Committee 2018 Annual IPM Program Status Report to the Transportation, Water, and Infrastructure Committee of the Contra Costa Board of Supervisors. Available: https://cchealth.org/ipm/pdf/2018-ipm-annual-report.pdf (Accessed: January 14, 2021).

[8] Contra Costa County. 2019. Contra Costa County Integrated Pest Management Advisory Committee 2019 Annual IPM Program Status Report to the Transportation, Water, and Infrastructure Committee of the Contra Costa Board of Supervisors. Available: https://cchealth.org/ipm/pdf/2019-ipm-annual-report.pdf (Accessed: January 14, 2021).

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[14] Example trade name: Dimension (unspecified).

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Table 2. Estimated Material Cost per Acre for Various Terrestrial Herbicides

Organization[1]	Year	Herbicide Type[2]			Active Ingredient(s)	Example Trade Name	Estimated Cost/Acre[3]	Notes	Reference
		Pre-Emergent	Post-Emergent	Organic/ Alternative					
SCCWRP	2019	✓			Aminopyralid	Milestone	$28	4	[1]
PCWA	2019	✓			Aminopyralid	Milestone VM	$17	4	[3]
SCCWRP	2019	✓			Chlorsulfuron	Telar XP	$50	4	[1]
UCANR	2016	✓			Dimethenamid, pendimethalin	Freehand 1.75G	$456	5	[5]
City of Watsonville	2018	✓			Dithiopyr	Dimension	$59	6	[3]
PCWA	2019	✓			Dithiopyr	Dimension 2EW	$54	4	[3]
SCCWRP	2019	✓			Dithiopyr	Dimension 2EW	$65	4	[1]
UCANR	2016	✓			Flumioxazin	BroadStar	$354	4	[5]
City of Watsonville	2018	✓			Indaziflam	Specticle Flo	$117	7	[3]
Corteva Agriscience	2020	✓			Indaziflam	Specticle G	$313	4	[2]
City of Watsonville	2018	✓			Isoxaben	Gallery SC	$182	6	[3]
Corteva Agriscience	2020	✓			Isoxaben	Gallery SC	$119	4	[2]
Corteva Agriscience	2020	✓			Isoxaben	Gallery 75 DF	$125	4	[2]
SCCWRP	2019	✓			Isoxaben	Gallery 75-D	$204	4	[1]
Corteva Agriscience	2020	✓			Oryzalin	Surflan AS	$102	4	[2]
SCCWRP	2019	✓			Oryzalin	Surflan Pro	$100	4	[1]
SCCWRP	2019	✓			Pendimethalin	Pendulum AquaCap	$59	4	[1]
SCCWRP	2019	✓			Prodiamine	Barricade 4FL	$27	4	[1]
SCCWRP	2019	✓			Sulfometuron-methyl	Oust XP	$21	4	[1]
Corteva Agriscience	2020	✓			Trifluralin, isoxaben	Snapshot 2.5 TG	$360	4	[2]
SCCWRP	2019		✓		Aminopyralid	Milestone	$15	4	[1]
SCCWRP	2019		✓		Clethodim	Grassout Max	$13	4	[1]
SCCWRP	2019		✓		Clopyralid	Transline	$28	4	[1]
SCCWRP	2019		✓		Diquat	Reward	$40	4	[1]
Wilbur-Ellis	2020		✓		Diquat	Reward	$20	6	[4]
SCCWRP	2019		✓		Fluazifop-p-butyl	Fusilade	$36	4	[1]
UCANR	2019		✓		Glufosinate	Finale	$35	8	[6]
City of Watsonville	2018		✓		Glufosinate	Finale	$80	9	[3]
SCCWRP	2019		✓		Glufosinate	Cheetah Pro	$30	4	[1]
Wilbur-Ellis	2020		✓		Glufosinate	Lifeline	$21	10	[4]
UCANR	2019		✓		Glyphosate	Ranger Pro	$14	8	[6]
PCWA	2019		✓		Glyphosate	Roundup Custom	$14	11	[3]
SCCWRP	2019		✓		Glyphosate	Roundup Pro	$20	4	[1]
City of Watsonville	2018		✓		Glyphosate	Roundup PROMAX	$24	12	[3]
PCWA	2019		✓		Glyphosate	Roundup PROMAX	$13	13	[3]
PCWA	2019		✓		Imazamox	Clearcast	$132	14	[3]
SCCWRP	2019		✓		Imazapyr	Polaris	$53	4	[1]
PCWA	2019		✓		Triclopyr	Vastlan	$32	15	[3]
SCCWRP	2019		✓		Triclopyr	Turflon Ester Ultra	$14	4	[1]
UCANR	2019			✓	Acetic acid	Nature's Wisdom	$1,491	8	[6]
SCCWRP	2019			✓	Acetic acid	Vinagreen Vinegar 20%	$899	16	[1]
UCANR	2019			✓	Ammoniated soap of fatty acids	Finalsan	$274	8	[6]
UCANR	2019			✓	Ammonium nonanoate	AXXE	$412	8	[6]
Wilbur-Ellis	2020			✓	Ammonium nonanoate	AXXE	$504	17	[4]
UCANR	2019			✓	Caprylic acid, capric acid	Suppress + Biolink	$227	8	[6]
SCCWRP	2019			✓	Caprylic acid, capric acid	Suppress	$540	18	[1]

Table 2. Estimated Material Cost per Acre for Various Terrestrial Herbicides

Organization[1]	Year	Herbicide Type[2]			Active Ingredient(s)	Example Trade Name	Estimated Cost/Acre[3]	Notes	Reference
		Pre-Emergent	Post-Emergent	Organic/ Alternative					
Wilbur-Ellis	2020			✓	Caprylic acid, capric acid	Suppress	$342	19	[4]
SCCWRP	2019			✓	Citric acid, clove oil	Burnout	$1,566	20	[1]
UCANR	2019			✓	Citric acid, clove oil	Burnout	$497	8	[6]
SCCWRP	2019			✓	Clove oil, cinnamon oil	Weed Zap	$622	21	[1]
UCANR	2019			✓	Clove oil, cinnamon oil	Weed Zap	$210	8	[6]
City of Watsonville	2018			✓	d-Limonene	Avenger	$1,664	22	[3]
SCCWRP	2019			✓	d-Limonene	Avenger	$535	23	[1]
UCANR	2019			✓	d-Limonene	Avenger AG	$240	8	[6]
UCANR	2019			✓	Eugenol, *Bacillus megaterium*	Weed Slayer	$115	8,24	[6]
UCANR	2019			✓	Iron HEDTA	Fiesta	$144	8	[6]
City of Watsonville	2018			✓	Pelargonic acid, fatty acids	Scythe	$1,318	25	[3]
UCANR	2019			✓	Pelargonic acid, fatty acids	Scythe	$216	8	[6]

Table 2 Notes:

[1] Abbreviations: Placer County Water Agency (PCWA), Southern California Coastal Water Research Project (SCCWRP), University of California Agriculture and Natural Resources (UCANR)

[2] Please note that the "Organic/Alternative" herbicides included in this table are a subcategory of post-emergent herbicides. Post-emergent herbicides not categorized above as organic/alternative are assumed to be conventional (i.e., synthetic).

[3] Cost assumes 1 treatment per year.

[4] Cost estimated based on highest labeled application rate.

[5] Cost estimated based on application rate of 120 pounds per acre.

[6] Cost estimated based on application rate of 32 fluid ounces per acre.

[7] Cost estimated based on application rate of 9 fluid ounces per acre.

[8] Cost estimated based on spray to wet field trial.

[9] Cost estimated based on application rate of 6 quarts per acre.

[10] Cost estimated based on application rate of 82 fluid ounces per acre.

[11] Cost estimated based on application rate of 120 fluid ounces per acre.

[12] Cost estimated based on application rate of 72 fluid ounces per acre.

[13] Cost estimated based on application rate of 3.3 quarts per acre.

[14] Cost estimated based on application rate of 64 fluid ounces per acre.

[15] Cost estimated based on application rate of 48 fluid ounces per acre.

[16] Cost estimated based on application rate of 30 gallons per acre.

[17] Cost estimated based on application rate of 12 gallons per acre.

[18] Cost estimated based on application rate of 9 gallons per acre.

[19] Cost estimated based on application rate of 6 gallons per acre.

[20] Cost estimated based on application rate of 29 gallons per acre.

[21] Cost estimated based on application rate of 5 gallons per acre.

[22] Cost estimated based on application rate of 81 quarts per acre.

[23] Cost estimated based on application rate of 8.5 gallons per acre.

[24] Pursuant to the Stop Use Notice, Statewide Quarantine, and Removal From Sale Order issued by the California Dept. of Food and Agriculture (CDFA) on December 4, 2020, purchase and use of this product is currently not permitted.

[25] Cost estimated based on application rate of 20 gallons per acre.

Table 2 References:

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[5] Wilen, C. 2016. 'Are you spending too much for container weed management?' Presentation. University of California Agriculture and Natural Resources.

[6] Cost estimated for irrigation canal with a narrow berm and no equipment accessibility.

APPENDIX C

Glyphosate Discontinuation Survey Responses

Appendix C. Glyphosate Discontinuation Survey Responses

Overview: Responses to the following questions from representatives of 10 entities are summarized below.

1. What is your name and role with your organization?
2. What are the primary site types in which your organization manages vegetation and why is it important to manage vegetation there?
3. Please describe how glyphosate use practices at your organization have changed in recent years. Is it being phased out, targeting reduced or specific use, discontinued, not applied in certain sites, etc.?
4. What are the primary application methods used when applying herbicides?
5. What herbicides were you using before vs. after the glyphosate reduction and in what amounts?
6. Are there any non-herbicide control methods that are used more often or on a wider scale since glyphosate use was reduced?
7. How have changes in glyphosate use practices impacted your organization's vegetation management program in terms of cost and labor hours needed?
8. On a scale of 1-10, how have changes in glyphosate use practices impacted the overall effectiveness/service levels of your organization's vegetation management program? (1 = dramatically decreased, 10 = dramatically increased)

Table 1. Summary of Survey Questions 1-3

Organization	1. What is your name and role with your organization?	2. What are the primary site types in which your organization manages vegetation and why is it important to manage vegetation there?	3. Please describe how glyphosate use practices at your organization have changed in recent years. Is it being phased out, targeting reduced or specific use, discontinued, not applied in certain sites, etc.?
City of Burbank	Mike Del Campo, Landscape and Forestry Superintendent	Mike is responsible for managing vegetation in the City's 27 parks, including ballfields, a golf course, and some undeveloped areas. The Burbank Park District maintains approximately 100 acres of parks. Vegetation management is conducted to maintain these areas both aesthetically and functionally for visitors to enjoy. Ballfield warning tracks must be maintained as bare ground areas to reduce tripping and falling hazards. When weeds become overgrown, they may also provide shelter and habitat for other pests such as rats, snakes, and mice, which can themselves lead to public safety issues.	City Council directed staff to stop using glyphosate in parks in 2017.

Table 1. Summary of Survey Questions 1-3

Organization	1. What is your name and role with your organization?	2. What are the primary site types in which your organization manages vegetation and why is it important to manage vegetation there?	3. Please describe how glyphosate use practices at your organization have changed in recent years. Is it being phased out, targeting reduced or specific use, discontinued, not applied in certain sites, etc.?
City of Carlsbad	Tim Selke is the city's Park Services Manager responsible for overseeing the Parks Maintenance Division and park planning and development.	Tim's staff manage parks, trails, open space, medians, parkways, and trees. Vegetation management is performed to maintain public safety, recreational use, and aesthetic qualities of these areas.	Glyphosate and other synthetic herbicide use was phased out in 2017 in favor of an "organics first" approach.
City of Healdsburg	Jaime Licea, Parks and Open Space Superintendent	The Parks Department manages vegetation in approximately 75 60 acres of neighborhood and downtown parks (including playgrounds, sidewalks, hardscape, drinking fountains, and athletic fields) and 320 acres of open space areas (including trails). This type of work is done for many reasons, such as the preservation of natural resources and ecological integrity, control of invasive weeds, promotion of healthy lifestyles by providing a variety of recreational facilities for public use, and maintenance of these facilities so they are both functional and aesthetically pleasing. The City of Healdsburg is a tourist destination and the Parks Department is funded by a city tourism tax. Because of this, stakeholders tend to have a low tolerance for weeds. In open space areas, there is also emphasis on reducing ladder fuels and maintaining the integrity of fire access roads. Jaime leads a team of 3 full time staff and hired additional part time staff and contractors after glyphosate use was discontinued. Note that the City's Water Department also has vegetation management responsibilities and contracts out the work.	Glyphosate was never formally banned by City officials; however, Parks staff discontinued its use in 2016. In 2015, the City conducted a review of the current science on glyphosate and did not find information indicating that it was a health concern. Despite this, the public perception of glyphosate in recent years was a challenge for staff who were confronted by residents during or after glyphosate applications as it can be difficult to have impromptu conversations about contentious topics such as herbicide use. Although glyphosate was only used by the Parks staff in very limited amounts (~2.5 gal/year), staff concerns about potential safety risks, public perception, and recent glyphosate litigation prompted its discontinuation within the department.
City of Richmond	Greg Hardesty, Parks & Landscaping Superintendent	Greg leads a 10-person team which is responsible for managing vegetation across 856 acres, including 56 of the City's 60 parks and rights-of-way and 22 miles of medians. Maintaining public safety and roadway visibility is a priority in rights-of-way. In addition, weeds and overgrown vegetation need to be controlled to preserve the aesthetic and recreational quality of City parks as well as to maintain fire breaks in open space. Because of current staffing limitations, efforts tend to focus more on general vegetation upkeep than on managing specific invasive weed populations.	All pesticides were prohibited from use following a City Council resolution approved in 2015.

Table 1. Summary of Survey Questions 1-3

Organization	1. What is your name and role with your organization?	2. What are the primary site types in which your organization manages vegetation and why is it important to manage vegetation there?	3. Please describe how glyphosate use practices at your organization have changed in recent years. Is it being phased out, targeting reduced or specific use, discontinued, not applied in certain sites, etc.?
City of Santa Cruz	Chris Berry, Watershed Compliance Manager and acting Integrated Pest Management (IPM) Coordinator for the City's Water Department	The Watershed Section of the City's Water Department is responsible for managing 2,800 acres of watershed land surrounding the Loch Lomond, which is used both for recreational activities and as a drinking water storage reservoir. Vegetation management in the watershed emphasizes fire fuel management, invasive species management, protection of biodiversity, and native plant restoration. Vegetation management activities are conducted by a small number of City staff, a contractor, and volunteers. Note that the Production and Distribution Sections within the Water Department are also responsible for managing vegetation; however, the current interview pertains only to the Watershed Section.	In 2017, the Santa Cruz City Council voted to implement a 6-month pilot program prohibiting the use of glyphosate-based herbicides on City property and conduct a review of the City's IPM Program and return to Council in 6 months with an update report including policies, implementation experience, current best practices, and possible revision. Currently, the glyphosate prohibition is still in effect as the IPM Program review is ongoing.
City of Watsonville	John Moreno-Ramirez, Public Works Utility Crew Leader for Field Services Division	Field Services is a division within the City's Public Works Department that is responsible for non-landscaping vegetation management in trails, open space, rights-of-way, alleyways, levees, city lots, and other sites. Maintenance of city roadsides, lots, and alleys is important for roadway and traveler safety, including minimizing safety risks, preserving the integrity of existing infrastructure, and reducing fire risks. Weeds growing within trail walking areas pose a safety hazard for trail users and hinder the habitat restoration efforts in the Watsonville Wetlands. Because of the fast-growing nature of many weeds, management activities in open space emphasize fire risk reduction, particularly in areas that abut homes and fence lines.	Watsonville's City Council passed a resolution discontinuing the use of glyphosate-based herbicides on all city properties in 2019.

Table 1. Summary of Survey Questions 1-3

Organization	1. What is your name and role with your organization?	2. What are the primary site types in which your organization manages vegetation and why is it important to manage vegetation there?	3. Please describe how glyphosate use practices at your organization have changed in recent years. Is it being phased out, targeting reduced or specific use, discontinued, not applied in certain sites, etc.?
Marin Municipal Water District (MMWD)	Shaun Horne, Watershed Resources Manager	The District is responsible for maintaining approximately 21,860 acres of land, including 7 municipal reservoirs with 79 acre-feet of storage, approximately 92 miles of fire access roads, 60 miles of hiking trails, picnic grounds, and parking areas. The District's vegetation management approach is described in detail in its Biodiversity, Fire, and Fuels Integrated Plan (BFFIP) and the associated Program Environmental Impact Report (EIR). The purpose of the BFFIP is to define and guide the methods to minimize the risk from wildfires while simultaneously preserving and enhancing existing significant biological resources. The BFFIP focuses on mechanical control methods and establishes an adaptive approach for vegetation management based on species inventorying and monitoring.	While initial drafts of the BFFIP allowed for the potential use of pesticides, pesticide use was written out of the plan as early as 2005 as a result of concerns raised by the public. The BFFIP was finalized in 2019 and does not allow for the use of pesticides. Glyphosate use, however, was discontinued prior to Plan finalization.
San Lorenzo Valley Water District (SLVWD)	Carly Blanchard, Environmental Planner. Carly is responsible for managing environmental projects, consultants, and restoration work related to environmental permitting, watershed, and stewardship.	SLVWD is responsible for approximately 2000 acres of watershed land and multiple small parcels housing District infrastructure. Primary site types include: Redwood forest, mixed evergreen forest, riparian woodland, and sandhills habitats. Many of the District's forested sites were historically used for timber, leading to new species moving into the canopy (such as invasive *Eucalyptus globulus*) and crowding between trees. During August 2020's CZU fires, a majority of SLVWD's forested land burned and will need to be evaluated for hazard tree removal and post-fire erosion. The District's sandhill properties contain rare endemic species and communities and need extra consideration to safely maintain drinking water well sites on the property. This land was previously a quarry and is heavily impacted by the invasive plant species French broom (*Genista monspessulana*).	The District Board voted to ban glyphosate in 2019 and establish an Integrated Pest Management (IPM) plan. The District's main use for the glyphosate was within its sandhill properties to control invasive French broom with cut stump applications. The District otherwise did not use glyphosate except for specific applications with invasive removal.

Table 1. Summary of Survey Questions 1-3

Organization	1. What is your name and role with your organization?	2. What are the primary site types in which your organization manages vegetation and why is it important to manage vegetation there?	3. Please describe how glyphosate use practices at your organization have changed in recent years. Is it being phased out, targeting reduced or specific use, discontinued, not applied in certain sites, etc.?
Town of Windsor	Olivia Lemen, Parks and Facilities Manager and Integrated Pest Management (IPM) Manager	Olivia manages 8 full-time employees (FTEs) and 6 part-time employees who are responsible for maintaining all town facilities (buildings), 19 parks (140 acres), streetscapes, and 28 miles of medians and roadways. Vegetation management is important in these areas both for aesthetic purposes and for public safety, including the reduction of fire risks. Two FTEs are responsible for all park and facility maintenance activities (e.g., irrigation repairs, planting projects, restroom upkeep) in each of the Town's 4 zones.	All synthetic pesticides were banned by the Town Council in 2018 in an effort to create a safer environment. The primary driver for this change was public concern over the use of glyphosate for vegetation management.
University of California, Davis (UC Davis)	Jean-Philippe (JP) Marie, Manager of the UC Davis Putah Creek Riparian Preserve	JP manages approximately 3.5 miles of riparian trial within the Putah Creek restoration area. He is also responsible for overseeing about 1,000 acres of grassland near Putah Creek, 600 acres of which are actively managed. Invasive weeds such as Giant reed (*Arundo donax*) and tree of heaven (*Ailanthus altissima*) in the restoration area need to be controlled. Due to their competitive nature, these weeds can become monoculture if left uncontrolled and can as a result have a detrimental impact on wildlife habitat. Within the trails themselves, the growth of weeds imparts a safety hazard for trail users. In grasslands, thatch and weeds must be controlled to reduce fire hazards.	In 2019, the UC system banned the use of glyphosate on UC campuses; however, exemptions to this ban were established for agricultural operations, fuel-load management programs to reduce wildfire risk, native habitat preservation or restoration activities, and research that requires the use of glyphosate. Although restoration areas such as Putah Creek are currently not required to cease use of glyphosate, JP's personal approach to vegetation management has involved reducing reliance on herbicides altogether. In the future, glyphosate use on UC campuses may be further restricted. JP acknowledged that controlling certain invasive species may be difficult without having glyphosate as an available control tool. Importantly, glyphosate and other herbicides should be considered *a* tool in integrated pest management (IPM), not the *only* tool.

Table 2. Summary of Survey Questions 4-6

Organization	4. What are the primary application methods used when applying herbicides?	5. What herbicides were you using before vs. after the glyphosate reduction and in what amounts?	6. Are there any non-herbicide control methods that are used more often or on a wider scale since glyphosate use was reduced?
City of Burbank	The most common application method used is spot spray using a backpack sprayer.	While Roundup (glyphosate) was previously used, Mike's staff currently use pre-emergent herbicides and the organic herbicides Scythe (pelargonic acid and related fatty acids) and Weed Pharm (acetic acid). Mike has experienced limited success with both pre-emergent and organic herbicides during field testing and sometimes needs to retreat an area with organic herbicides monthly to maintain satisfactory control. While many people tend to think of organic herbicides as "safe" and "environmentally friendly," it's important to remember that many of these products are more dangerous to applicators and require an increased level of Personal Protective Equipment (PPE). Similarly, people and pets that come into contact with weeds that have recently been sprayed and are not yet dried can get skin irritation or burns from the concentrated materials.	More manual and mechanical work is performed now. Typical non-chemical control methods include mowing, blowing, edging, hand pulling, and tree maintenance. In addition, the City recently expanded its volunteer program to help pull weeds. When public complaints are received regarding weeds, Mike thanks callers for alerting him and for acting as an extra set of eyes. He often encourages a volunteer group to assist with hand pulling weeds at the problem site. Parks staff also implement cultural controls to discourage weed growth such as replanting areas with drought-resistant plants and other desirable ornamentals, maintaining turf health, aerating turf, top dressing, and overseeding. In 2019, landscape crews tested the use of a foam steam machine for weed control in ballfield warning tracks. While organic herbicides were incorporated into the foam, the combination of foam, steam, and organic herbicide was found to be much more effective and long lasting than using organic herbicides alone or removing weeds mechanically using heavy equipment. Results from the foam steam treatment suggested that adequate control of warning track weeds could be maintained with 3 or 4 treatments per year, comparable to a glyphosate treatment; however, while faster than hand pulling, foam steaming is a slow process and would roughly quadruple the time needed to complete a treatment compared to traditional herbicide applications. Furthermore, the equipment is expensive (nearly $150,000 for the foam steam machine and buggie). Goat grazing, a form of biological control, has been considered but is not suitable for the City's park facilities.

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City of Carlsbad	The primary application methods used are backpack sprayer and handsprayer.	While glyphosate-based products were previously used, the primary products currently used for post-emergent broadleaf weed control include Axxe (ammonium nonanoate), Scythe (pelargonic acid and related fatty acids), and Fireworxx (caprylic and capric acids).	Yes, mechanical weed removal and cultural practices such as mulch installation or the installation of weed barriers are done more regularly than in the past.
City of Healdsburg	A backpack sprayer was always used for herbicide applications.	Prior to its discontinuation, approximately 2.5 gallons of a glyphosate-based herbicide such as Rodeo was used per year. Currently, no herbicides are used for park and open space maintenance. After discontinuing glyphosate use, the Parks Department tested the use of the organic herbicide Suppress (caprylic and capric acids); however, it did not result in satisfactory control because it just burned the top of the foliage rather than killing the weeds. Weed Slayer (eugenol) was also tested and appeared to be more effective than Suppress; however, staff found that they needed to apply it frequently (about every 2-3 weeks) in order to maintain weed control. Due to its high price (~$1,200/2.5 gal Weed Slayer versus ~$40/2.5 gal Rodeo) and application frequency, Weed Slayer was not formally adopted as a vegetation management tool and instead part time staff were hired to control weeds mechanically.	A variety of non-herbicide control methods are used to manage weeds. For example, high weed areas are mowed 2-3 times per year. In other areas, methods such as mulching, installing weed mats, weed whacking, overseeding, and mowing are used. Where possible, more proactive control strategies such as installing drip irrigation systems and introducing native plant seeds in some trail areas are used to prevent or reduce the spread of weeds.

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City of Richmond	Backpack sprayers, boom sprayers, and mechanically pressurized handsprayers are used. Medians and some park areas are treated using a truck-mounted spray rig or backpack.	Previously, Roundup Pro (glyphosate) was selectively applied to control weeds growing from hardscape cracks, Ronstar (oxadiazon) was used as a pre-emergent in medians and some park areas, Turflon (triclopyr) was used to control weeds in lawns, and Fusilade (fluazifop-p-butyl) was used to control grasses. After the pesticide prohibition, a few organic herbicides were tested on a trial basis: Weed Slayer (eugenol), Weed Pharm (acetic acid), Suppress EC (caprylic and capric acids), and Avenger (d-limonene). As these organic herbicides are "top burn" only, weeds grew back quickly and satisfactory control was not achieved. Currently, no herbicides are used.	Weeds growing in medians are weed whacked or hand pulled. In larger areas, weeds are mowed. The use of weed whackers in medians has resulted in several broken window claims as well as worker's compensation claims due to the repetitive motions staff make. Spending an increased amount of time working in medians also presents a safety issue for staff.
City of Santa Cruz	Backpack sprayer and truck- or ATV-mounted handgun sprayer.	The City is currently refining its process for approving pesticides for use in the IPM Program. Prior to the glyphosate prohibition, glyphosate-based herbicides approved for use in aquatic sites had been used sparingly (primarily along ridgetop fuel breaks and key fire access roads) and included pre- and post-treatment monitoring. As an extra precaution, no glyphosate was applied in the drainage area of the reservoir. Today, no suitable herbicides have been approved for regular, ongoing use in the watershed. In 2020, however, the Watershed Section was granted a temporary exception for limited use of Roundup Pro (glyphosate) in select areas that do not drain directly to City water supplies and are not accessible to the public. In 2019, the Watershed Section tested Mirimichi Green (ammonium nonanoate) for French broom control. This product appeared to be somewhat effective but did not offer the same degree of control as glyphosate. 2 gallons of Mirimichi Green were used in 2019.	Hand pulling and cutting have been conducted much more frequently and widely since glyphosate use was restricted. Due to staff limitations, these methods are typically performed once annually at each site, although it is not always possible to reach all sites that need attention. Flaming, steaming, and foaming have been tested or considered as control methods in the past but were not considered suitable for routine, widespread use in the watershed.

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City of Watsonville	Prior to the glyphosate prohibition, 4-gallon backpack sprayers and 100-gallon truck-mounted spray rigs were most commonly used. Because the sites maintained by Field Services are large in number and/or size and are often kept as bare ground areas, most applications (~90%) were made using the spray rig. Backpacks were more typically used for touch ups and not used to the same extent. Since discontinuing glyphosate use, the City has been using a glufosinate-based product with label language prohibiting application via motorized equipment. As a result, 100% of the herbicide applications made by John's team are made with a backpack sprayer. For the upcoming weed season, John's team intends to switch to an alternative glufosinate-based herbicide that is permitted for use with motorized equipment.	Roundup PROMAX (glyphosate) was previously used to achieve bare ground control (~10 gal/year for all sites). Currently, weeds are controlled using glufosinate-based post-emergent and pre-emergent herbicides. In the 2020 weed season, Forfeit 280 (glufosinate), Dimension (dithiopyr), and Gallery (isoxaben) were used. In 2021, city staff intend to use Cheetah (glufosinate) and Specticle Flo (indaziflam) to manage weeds. Glyphosate- and glufosinate-based products likely have a similar application rate; however, because glufosinate is a burndown chemical rather than a systemic one, John expects that sites with stubborn weeds will need to be treated more frequently. The application rate for Specticle Flo is about four times lower than that of glyphosate. Organic herbicides have been considered for use in the past but are not currently used by city staff due to efficacy concerns and cost.	Sites with perennial weeds that are not controlled by pre-emergents need to be mowed and/or weed whacked more often between applications. Despite this, the utilization of pre-emergent herbicides has been an important component of the city's glyphosate phaseout. If only Forfeit 280 were to be used, much more time would need to be spent doing weed whacking.
Marin Municipal Water District (MMWD)	Herbicides are not used by the District; however, when herbicide use was being considered, staff experimented with a number of different application methods based on the type of plant they were targeting.	Glyphosate was used for foliar applications several years ago. After glyphosate use was discontinued, MMWD staff tested organic herbicides such as foam sprays. The organic products did not offer sufficient control and were therefore not adopted as part of the District's vegetation management approach.	Hand pulling is the primary control method used for invasive weeds. To maintain defensible space, equipment is used for masticating fuels, roadside brushing, and mowing/weed eating fire breaks. Goat grazing was tested in the past but presented its own challenges. For example, concerns were raised that not all sites are suitable for grazing and that goats may eat the rare plants that the District strives to protect. In addition, trees required protection to prevent goats from eating the bark, increasing the cost associated with this control method. Concerns were also raised about the potential for goats to introduce weeds into previously unimpacted areas. In one instance, a large starthistle outbreak occurred as a result of grazing.

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San Lorenzo Valley Water District (SLVWD)	Cut stump was the primary application method. An herbicide solution (usually glyphosate mix) was applied directly to the stump top immediately after cutting down the plant. The herbicide kills the stump and prevents new growth that would normally occur after cutting alone. No spraying was conducted.	In 2016, less than 4 gallons of glyphosate-based herbicide was proposed for use throughout the District's 40 acres of sandhills properties via cut stump treatment. Due to public concern, no herbicide has been used since 2016. The District is currently considering use of SureGuard (flumioxazin) for vegetation management.	On non-sandhill properties, weed whacking is extensively used and is usually done 3-4 times per year. Bare ground areas such as access roads are maintained by more frequent mowing and cutting. The District has approximately 90 tank sites all with their own access roads. Due to the sensitive nature of the sandhill properties, crews to hand pull invasive weeds and a U.S. Fish & Wildlife permit to conduct the work will be needed. However, pulling alone will not be a long-term solution unless annual commitment is made to maintain area (at least once per year).
Town of Windsor	Organic herbicides are primarily applied using a backpack sprayer. Mechanically pressurized handsprayers or Gator-mounted sprayers are also used, but to a lesser extent.	Prior to the ban on synthetic pesticides, glyphosate and pre-emergent herbicides were used. For example, pre-emergents would be applied in the fall and a glyphosate-based herbicide would be applied as needed during the growing season. So far, staff have not found a suitable replacement for the use of pre-emergents but have had some success with organic herbicides. When using organic herbicides, several factors such as the time of year, temperature, and moisture can substantially influence the efficacy of each application. Examples of organic herbicides that may be used include Weed Slayer (eugenol), Weed Zap (clove and cinnamon oils), and Whack Out Weeds (peppermint oil, potassium sorbate, and sodium chloride). Depending on the weather, sites may be treated with such products 3-5 times per year.	Lots of trimming is done. Typically, staff trim weeds prior to organic herbicide application as well as trim dead biomass after application. This may occur 3-4 times per year. Staff hand pull weeds in high-profile areas and may contract out hand pulling tasks for specific projects. Other control methods that are used include mulching and converting overhead irrigation to drip irrigation. In some areas, desirable plants and hedges are installed to help compete with weeds. Mowing is performed by a contractor. While bedding and edging are also currently performed by contractors, contractors have reported difficulty keeping up with weeds due to the synthetic pesticide ban. Flaming weeds on hardscapes has also been considered; however, this control method has not been adopted at this time in acknowledgement of the public's concern regarding fire risks.

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University of California, Davis (UC Davis)	JP primarily uses a backpack sprayer or an ATV-mounted electric tank and boom to make broadcast applications to the trail area. Not all areas are accessible via ATV. Use of the backpack versus ATV-mounted boom is about equal.	Previously, trails were treated with a pre-emergent herbicide such as Surflan (oryzalin) along with an aquatic-labeled glyphosate product such as Aquamaster. This year, the trails were treated with an aquatic-labeled, imazapyr-based herbicide called Habitat. JP has also recently been involved with trials of organic herbicides such as Suppress (caprylic and capric acids), ADIOS (sodium chloride), and Avenger (d-limonene) for use in grassland areas. These products cannot be used in riparian areas as they are not aquatic-labeled. Organic herbicides have not been formally adopted for regular use due to their high cost, high application rate (80-200 gallons of solution per acre), and low efficacy in trials.	In the trail area, mowing and weed whacking are conducted in between herbicide treatments (twice per year on average). Because weed control lasts roughly the same amount of time when using imazapyr vs glyphosate, mowing frequency has largely remained the same. Other non-chemical control methods are also currently being used on a similar scale pre- and post-glyphosate ban include cattle grazing and prescribed burns in grassland areas.

Table 3. Summary of Survey Questions 7-9

Organization	7. How have changes in glyphosate use practices impacted your organization's vegetation management program in terms of cost and labor hours needed?	8. On a scale of 1-10, how have changes in glyphosate use practices impacted the overall effectiveness/service levels of your organization's vegetation management program? (1 = dramatically decreased, 10 = dramatically increased)
City of Burbank	Costs went from about $3,000 per year for 100 gallons of glyphosate to almost $100,000 per year for thousands of gallons of organic herbicides. In addition to being less effective than conventional herbicides, the long-term effects of applying such high volumes to the environment are unknown. A lot more time is also spent when applying organic herbicides compared to conventional herbicides since sites need to be treated more often and applications take longer to dry (staff must remain at the site to see that the public does not enter treated areas until they have dried). While Mike currently has a landscape team of 24 staff members, a team of roughly twice the size would be ideal.	4. Overall, Mike is satisfied with current service levels but expressed that this score is subjective since he has personally learned to adjust his expectations and tolerance for weeds. Residents, on the other hand, may expect a level of service that is only feasible with the continued use of conventional post-emergent herbicides such as glyphosate. Oftentimes, landscape crews must focus their efforts on highly visible areas such as entrance ways and parking lots and staff have less time to perform other park maintenance tasks because much more time is spent pulling weeds than in the past. An important factor in implementing a vegetation management program like the City's is public education. During public complaint calls, for instance, Mike provides information about why there is increased weed presence in parks and tries to encourage increased tolerance for such growth.
City of Carlsbad	Generally, the organics first approach does have an increased cost of product and labor due to need for repeated and/or more frequent applications.	5
City of Healdsburg	More labor hours were needed to control weeds mechanically in lieu of herbicide use. Additional part time staff were hired to weed whack sites from March/April until June/July, then retreat sites again in November/December. These staff hires resulted in an increase in cost of about ~$3,000-$5,000 per month depending on staff availability. Additional funding would be desirable, but it is often difficult to effectively communicate the need for more funding to abate weeds.	Closer to 1 or 2 based on stakeholder expectations. Glyphosate was the most effective method of vegetation management in many instances and although its use was discontinued, the expectation of well maintained, aesthetically pleasing landscapes remained. Jaime notes that getting the public and other stakeholders to be more accepting of weeds requires a lot of work to educate and increase awareness of IPM, why vegetation management is important, and the advantages and disadvantages of different control methods.
City of Richmond	Prior to the pesticide prohibition, ~$50,000 was spent annually on vegetation management and 2 staff members would visit and, if necessary, treat a site every couple months. After the prohibition, millions of dollars have been spent annually to cover the cost of staff overtime, equipment, fuel, and worker's compensation claims. Depending on the time of year, multiple staff members may need to visit a given area every couple weeks to manage vegetation using non-herbicide controls. To return to the same level of service as before, Greg estimates that a crew of 30-40 people would be needed to provide pre-ban level of service.	2, based on current staffing levels

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City of Santa Cruz	The lack of ability to use glyphosate has limited the Watershed Section's ability to control fuels on key firebreaks around the primary drinking water storage reservoir, thereby increasing risk of fire related impacts to the City's water supply. Labor requirements for managing watershed vegetation have increased by orders of magnitude. While a contractor used to complete herbicide applications within a couple of days, multiple staff now spend weeks conducting mechanical controls such as hand pulling and cutting. Due to staffing limitations hindering the ability to reach all sites that need management, a temporary exception for limited use of Roundup Pro (glyphosate) was requested and granted earlier this year. As a result of this exemption, glyphosate was selectively applied in one particularly difficult area within the watershed. Costs historically associated with herbicide application (e.g., obtaining Pest Control Adviser recommendations and conducting water quality monitoring) have decreased since vegetation is primarily controlled mechanically; however, these costs may be reinstated should an alternative herbicide be adopted to the City's IPM Program. In addition, Mirimichi Green is more expensive and less effective than glyphosate-based herbicides.	2, based on current staffing levels
City of Watsonville	When using Forfeit 280, more time and resources were needed since applications could only be made using a backpack sprayer. Cheetah is expected to take about the same amount of time to apply as glyphosate but is about twice the cost. Because a relatively small amount of glyphosate was previously used, this increase in cost is not considered a critical drawback. The use of glufonsinate-based herbicides also contributes to more time spent trying to control perennial weeds such as blackberry and fennel. In the Watsonville Wetlands in particular, the spread of invasive blackberry impacts restoration efforts.	In specific areas where residents have requested that no herbicide be used, there is an increased number of public complaints about weed presence (score: 1). In other areas, services levels have somewhat decreased compared to previous service levels due to the reduced control of perennial species (score: 2-3).

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Marin Municipal Water District (MMWD)	Budget had to be increased to compensate both for the increased number of labor hours needed to manually control vegetation and for the increased number of acres targeted for management each year. The BFFIP outlines anticipated costs for various Plan activities as well as a plan to scale up management acres and budget each year over 5 years. Recently, this preliminary cost and work plan was modified to occur over 10 years instead of 5 years. Costs not captured in the BFFIP, however, include the extent of costs required for environmental compliance (e.g., required rare plant surveys, nesting bird surveys, avoidance of sensitive zones) and increasing costs associated with contractor rates. Preparation of an EIR for the BFFIP, however, has allowed the District to seek grant opportunities for additional funding.	In general, service levels have increased to due increased budget (score: 7). Effectiveness of eradication efforts, however, has decreased. For broom management, a score of 4 is appropriate due to the robust management program that was already established, including plant mapping, Early Detection Rapid Response approach, and manual and mechanical control strategies.
San Lorenzo Valley Water District	Due to funding restrictions, the ban has almost ceased restoration in sandhill areas because so much additional staff time would be required to conduct manual removal of French broom. Regular maintenance to maintain defensible space and road clearance still occurs but control activities have to happen more often without herbicides. The cost difference would need more research. Currently, 2-3 staff spend at least 1-2 days three times per year keeping roads and access points clear compared to once a year with glyphosate. In addition, the District intends to scale up vegetation management efforts on its watershed properties (2,000 acres). Historically, the District managed its watershed lands by "no active management" – only keeping road access, intakes, and pipelines clear. As these vegetation management plans become more clear, the District will likely have to work with consultant crews to move the larger work forward. As the District's fire management plans move forward, the District will need to begin clearing 100-200 ft buffers around tank sites. The contractor labor hours and cost to complete this work is currently unknown.	2-3; decreased with the final outcome to be determined. Funding commitment from the Board of Directors for restoration will play a large role in future vegetation management.

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Town of Windsor	Vegetation management is much more expensive without the use of synthetic herbicides. Olivia estimated that the cost for purchasing organic herbicides is approximately triple that of synthetic herbicides. In addition, the Town's maintenance contract increased by $100,000 to more than double the amount of its previous contract for mowing, bedding, and edging. Despite the increased contract amount, it is still difficult for contractors to keep up with weed growth. Olivia emphasized that the timing of weed control activities is very important, particularly from the perspective of seedbank management. If weeds are not controlled before they set seed, a single plant may produce tens to hundreds of seeds in one season. Properly timed treatments can be difficult to achieve with current staffing levels. In the future, 2 additional FTEs may be hired to help support vegetation management efforts.	This varies depending on the time of year. Right now (late October), service levels are largely consistent (4.5) with pre-ban service levels since springtime weeds have been controlled. Other times, such as during major growing seasons and after rain events, service levels can be greatly reduced (2). Since discontinuing the use of synthetic herbicides, weed populations occurring in the Town have grown significantly. Olivia acknowledged that the loss of pre-emergent herbicides as a tool for vegetation management has likely had a bigger impact on service levels than the loss of glyphosate.
University of California, Davis (UC Davis)	Overall, the cost and labor required for vegetation management along the trail system is roughly equal. The imazapyr-based herbicides currently being used have a lower application rate than previously used glyphosate products but cost more per gallon. Prior to switching to imazapyr, the trail system was managed using only manual control techniques for 2 years. Four (4) volunteers hand removed weeds once per week. Using this approach, it took 6 months for volunteers to control weeds along the trail. In comparison, a treatment using herbicides can be completed in 1 day. During organic herbicide trials, a single treatment was estimated to cost $800/acre. Because organic herbicides typically only control the aboveground portion of weeds, more than one application may be necessary to achieve and maintain adequate control. Grazing and burning in grasslands are currently conducted for free. UC Davis has cows available for use and the local fire department uses prescribed burn events as training opportunities for new recruits. Approximately 200 acres were treated in 2020 with prescribed burns.	5 (neutral) when comparing the glyphosate-based approach to the imazapyr-based approach in trials or the grazing/burning approach in grasslands. These programs all work well. 1 when comparing the glyphosate- or imazapyr-based approach to the organic herbicide-based approach. Service levels were also reduced when controlling trail area weeds by hand removal only since the time required to complete one "treatment" is much greater than time required to make an herbicide application.

Scotts Flat Reservoir

Lake Wildwood

SMITH GORDON CANAL

Rollins Reservoir

Camp Far West Reservoir

Lake Combie

Rock Creek Lake

DOTY SOUTH CANAL

LINCOLN

HEMPHILL CANAL

20

49

174

65

193

HEMPHILL CANAL

SMITH GORDON CANAL

DOTY SOUTH CANAL

NEVADA IRRIGATION DISTRICT
INTEGRATED VEGETATION MANAGEMENT PROGRAM
PHASE 3 REPORT

BACKGROUND

Nevada Irrigation District (NID or District) is an independent special district located on the western slope of the Sierra Nevada mountain range. The District encompasses 287,000 acres with available water in wide areas of Nevada, Placer and Yuba counties and storage and distribution facilities in Sierra and Yuba counties. The District service area ranges from 138 feet to 6,600 feet in elevation and includes a variety of landscape cover types including conifer forest, oak woodland, grassland, foothill residential areas and lowland residential areas. NID is organized primarily to supply water for irrigation, municipal, domestic and industrial purposes.

In an effort to deliver a reliable low cost source of water to customers, the District's Integrated Vegetation Management (IVM) Program incorporates the use of biological, chemical, cultural, manual and mechanical treatments to control vegetation growth in and around District infrastructure. Unmanaged vegetation can choke off canals, reduce water storage capacity and impact water quality and public health. The District IVM Program is a critical element of canal and reservoir maintenance, supporting adequate water flow for human consumption, irrigation and fire suppression.

The District IVM Program aims to continue implementation of adaptive management techniques that are environmentally sound, effective, efficient, fiscally prudent and compliant with regulatory requirements. In researching new and innovative vegetation control methods to add to its IVM Program, District efforts have included trial studies with UC Davis researchers using acetic acid (vinegar), barley straw and corn gluten, thermal steaming, burning, tarping, grazing and organic herbicide testing.

Phase 1 Pilot Study

In 2017, NID initiated evaluation of alternative strategies to vegetation management through a Pilot Study (Phase 1). Phase 1 included two activities: 1) review and coordination with the Vegetation Management Working Group and 2) field testing of alternative herbicides and mechanical approaches.

The Vegetation Management Working Group comprised local farmers, ranchers, representatives of the agricultural industry and others (such as the Placer and Nevada County Ag Commissioners and the Nevada County Resource Conservation District). NID convened the group to obtain information and guidance regarding integrated approaches to vegetation management. The group met several times and provided information and guidance for the field-testing portion of Phase 1.

In fall of 2017, District staff and consultants designed a pilot field study and prepared a grant proposal for submission to the Department of Pesticide Regulation's Research Grants Program. Although the grant was not awarded, the process of developing the application helped the District to establish an IVM team and catalyzed the field study efforts. Beginning in spring 2018, the District initiated a Phase 1 field test of alternative herbicides, biological and mechanical treatment methods. The study design included

application, data collection and data analysis of treatment efficacy based on percent control and percent cover. Nine organic herbicides, two mechanical treatment methods (mowing and abrasion weeder) and goat grazing were tested. Phase 1 identified a number of organic herbicides that produced greater measurable results to support additional trial testing and served to collect cost and efficacy information on mechanical and grazing treatments.

Phase 2 Study

In 2018, NID initiated a Phase 2 Study that expanded the trials of alternative herbicides that demonstrated the greatest measurable results in Phase 1. The Phase 2 Study also included mechanical treatment using steam and burn treatments, as well as analysis of native vegetation plantings. The results of the Phase 2 Study identified Opportune, Weed Slayer and Scythe as the top performing alternatives. Results of the Phase 2 Study supported continued study of the top performing alternatives along longer segments of canals and a study of the costs of removing glyphosate from the District IVM Program.

Although the Phase 2 Study mechanical treatments (steam and flame) demonstrated application rates 15 to 30 times longer than current method application rates, the District is committed to continuing its collaboration with the vendor to explore fabrication of a boom style arm for more practical application. In addition, the District has continued monitoring of the native plantings and found significant overgrowth of the plantings which has required labor-intensive manual cutting and removal of the subsequent material off-site.

INTRODUCTION

The District IVM Program has maintained steady efforts in research and investigation of new and innovative vegetation control tools and techniques. In 2019, NID initiated a Phase 3 Study to evaluate the efficacy of Opportune, Weed Slayer and Scythe herbicides along segments of the District's Combie Phase III Canal and Auburn Ravine II Canal. As Opportune, Weed Slayer and Scythe were identified as the top performing alternative herbicides of the Phase 2 Study they were applied in trial applications along the test segments of the Combie Phase III Canal and Auburn Ravine II Canal.

MATERIALS AND METHODS

Study Plot Locations

The Phase 3 Study test plots were established on the Combie Phase III and Auburn Ravine II Canals. These sites were selected as the test plot locations because of the uniformity of vegetation type and density along contiguous segments of canal. The Phase 3 Study focused on two test plot segments due to the limited availability of the organic product Opportune. Opportune has yet to be released on the market.

The test site on the Combie Phase III Canal is located in Nevada County, at an elevation of 1,280 feet in a grassland vegetation type. The test site on the Auburn Ravine II Canal is located in Placer County, at an elevation of 340 feet in a grassland vegetation type. Each plot was 660 feet long and 8 feet wide. Table 1 provides Phase 3 trial locations summary information.

Table 1: Phase 3 Application Sites

Test Site	Elev. (FT)	Nearest City	County	Plot Acreage	Vegetation & Soil Type
Auburn Ravine II Canal	340	Newcastle	Placer	0.12	***Vegetation*** Mediterranean California naturalized annual and perennial grassland [CNDDB] ***Soil*** Caperton-Andregg course sandy loams [NRCS]
Combie Phase III Canal	1,280	Grass Valley	Nevada	0.12	***Vegetation*** California naturalized annual and perennial grassland [CNDDB] ***Soil*** Auburn-Rock outcrop complex [NRCS]

Alternative Herbicides Applications

The Phase 3 Study included Opportune, Weed Slayer and Scythe – the top performing alternative herbicides identified through the Phase 2 Study. Table 2 provides summary information about Opportune, Weed Slayer and Scythe. Table 3 lists application rates and product cost per acre for each alternative herbicide.

Table 2: Phase 3 Alternative Herbicides Summary Information

Product	Active Ingredient	EPA Signal Word[1]	Required Personal Protective Equipment
Opportune	Microbial compound (dead, non-viable *Streptomyces acidiscabies* strain RL-110T cells and spent fermentation media)	Caution	Long sleeve shirt, long Pants, shoes plus socks waterproof gloves, filtering face piece respirator
Scythe	Pelargonic Acid	Warning	Coveralls over short-sleeve shirt and short pants, chemical resistant-gloves, chemical-resistant footwear plus socks and protective eyewear
Weed Slayer	Eugenol (essential oil of clove) and molasses	Exempt	Safety glasses an gloves

Table 3: Application Rates and Costs per Acre for Each Alternative Herbicides

Product	Recommended Application Rate	Cost per Acre[2]	Vendor
Opportune	3 gallons/acre	Unavailable	Marrone Bio innovations
Scythe	7% concentrate	$1,539.00	Gowan Company
Weed Slayer	32 oz. Part A/acre plus 32 oz. Part B (surfactant)/acre	$138.75	Agro Research Intl. LLC

[1] Federal regulation group pesticides into three categories according to toxicity and potential to injure people or the environment: DANGER, WARNING or CAUTION. Pesticides labels indicate these categories to show a product potential to cause injury if not used according to label instructions. Products with the signal word CAUTION are lower in toxicity and indicate the product is slightly toxic if eaten, absorbed through the skin, inhaled, or it causes slight eye or skin irritation. Products with the signal word WARNING indicate the pesticide is moderately toxic if eaten, absorbed through the skin, inhaled, or it causes moderate eye or skin irritation. DANGER means the product is highly toxic by at least one route of exposure – it may be corrosive, causing irreversible damage to the skin or eyes; and/or it may be highly toxic if eaten, absorbed through the skin, or inhaled.

[2] Cost per acre is calculated assuming 30 gallons of solution applied per acre.

District staff performed Phase 3 Study applications using a side-by-side boom sprayer. District staff mixed and applied the study herbicides according to the recommended protocol provided after the Phase 2 Study. District staff followed regulated material label and safety data sheet (SDS) instructions for use of personal protective equipment (PPE) during mixing and application and also adhered to the label and SDS specified environmental condition application limitations (e.g., wet and/or windy conditions).

Table 4 provides a summary of Phase 3 Study alternative herbicide applications.

Table 4: Phase 3 Alternative Herbicides Applications

Date	Location & Activity	Alternative Herbicide Applied
2019.12.05	Auburn Ravine II – Application #1	Opportune + Weed Slayer
2019.12.05	Combie Phase III – Application #1	Opportune + Weed Slayer
2020.01.10	Auburn Ravine II – Application #2	Opportune + Weed Slayer
2020.01.10	Combie Phase III – Application #2	Opportune + Weed Slayer
2020.03.06	Auburn Ravine II – Application #3	Scythe
2020.03.06	Combie Phase III – Application #3	Scythe

Monitoring and Data Collection

Monitoring and evaluating effectiveness of a treatment used the observed effect method to replicate the common field practice used for its efficiency of implementation. District staff monitored and evaluated the sites using the observed effect evaluation criteria also used during the Phase 2 Study. This observed effect monitoring evaluates percent control of vegetation, estimating overall plant response to the applied products based on set criteria categories as defined in Table 5.

Table 5: Phase 2 & 3 Study Percent Control Evaluation Criteria

% Impact	Observed Effect
0%	No effect.
10%	Minor plant stunting or curling of leaves and stems.
20%	Stunting or curling is more pronounced and plant is still mostly green.
30%	Leaf margin or chlorosis increase to approximately 1/3 of plant surface.
40%	Symptoms have increased with more severe leaf chlorosis but affecting less than 50% of plant surface or population in the treatment area.
50%	Approximately half of the weeds present in the treatment area display stunting, curling, chlorosis and/or necrosis on 50% of the plant leaves or stems.
60%	Slightly more than half of the weed population present in the treatment area display severe chlorosis or necrosis.
70%	Chlorosis and/or necrosis symptoms now present on most plants but still about 30% of plant tissue is green.
80%	Symptoms have expanded or increased to a majority of plants present but some still functioning tissue.
90%	A majority of plants in the treatment zone are displaying complete mortality but a few remaining plants have not been completely killed.
100%	All plants in treatment area are completely affected by the treatment and are dead.

Table 6 provides the categories used to further describe the range of control based on the observed percent impact.

Table 6: Range of Control Categories

% Impact Range	Category
0 – 50%	Poor Control (P)
51 – 80%	Fair Control (F)
80 - 95%	Good Control (G)
96 – 100%	Excellent Control (E)

Effort was made to collect data along the test sites at intervals close to 7, 14, 28, 45 and 60 days after application. Table 7 provides a summary of Phase 3 Study monitoring and evaluations events.

Table 7: Phase 3 Monitoring and Evaluation Dates

Date	Location & Activity
2019.12.11	Auburn Ravine II – Monitoring and Evaluation #1
2019.12.11	Combie Phase III – Monitoring and Evaluation #1
2019.12.19	Auburn Ravine II – Monitoring and Evaluation #2
2019.12.19	Combie Phase III – Monitoring and Evaluation #2
2020.01.06	Auburn Ravine II – Monitoring and Evaluation #3
2020.01.06	Combie Phase III – Monitoring and Evaluation #3
2020.01.21	Auburn Ravine II – Monitoring and Evaluation #4
2020.01.21 & 22	Combie Phase III – Monitoring and Evaluation #4
2020.02.07	Auburn Ravine II – Monitoring and Evaluation #5
2020.02.07	Combie Phase III – Monitoring and Evaluation #5
2020.03.05	Auburn Ravine II – Monitoring and Evaluation #6
2020.03.05	Combie Phase III – Monitoring and Evaluation #6
2020.03.12	Auburn Ravine II – Monitoring and Evaluation #7
2020.03.12	Combie Phase III – Monitoring and Evaluation #7
2020.03.30	Auburn Ravine II – Monitoring and Evaluation #8
2020.03.30	Combie Phase III – Monitoring and Evaluation #8
2020.04.28	Auburn Ravine II – Monitoring and Evaluation #9
2020.04.28	Combie Phase III – Monitoring and Evaluation #9

Data Analysis

As prescribed by the protocol that was informed and developed out of the Phase 2 Study, the Phase 3 data analysis was designed to show the efficacy of the alternative herbicide applications over greater study plot areas over time. Using the monitoring data collected, the analysis provided the opportunity to develop and forecast an alternative herbicide application schedule with the goal of fulfilling the necessary range of vegetation control that supports water quality and health, reliable delivery to customers, employee safety and wildfire prevention.

The following tables and graphs provide summary of the percent control data collected over the course of the Phase 3 Study. Line graphs display the range of control observed with the specific alternative herbicide application dates. Presenting the range of control data with the application dates aid in understanding the responsiveness of vegetation to the alternative herbicide applications, identify trends useful in forecasting control and consider the application schedule necessary to meet control targets.

Table 8: Percent Control Observed at Auburn Ravine II Canal

	DATE								
PLOT	**Dec. 11, 2019**	**Dec. 19, 2019**	**January 6, 2020**	**January 21, 2020**	**February 7, 2020**	**March 5, 2020**	**March 12, 2020**	**March 30, 2020**	**April 28, 2020**
AR2-01	10	70	10	80	90	0	50	80	0
AR2-02	70	70	10	80	80	0	60	60	0
AR2-03	70	70	10	80	70	0	30	60	0
AR2-04	70	70	10	70	90	0	60	20	0
AR2-05	10	70	10	90	80	0	70	20	0
AR2-06	20	70	20	90	90	0	70	40	0
AR2-07	20	70	10	50	60	0	60	30	0
AR2-08	20	70	15	80	60	0	70	70	0
AR2-09	20	50	15	85	90	0	70	40	0
AR2-10	20	60	10	50	90	0	40	30	0
AR2-11	10	40	5	70	60	0	40	40	0
AR2-12	10	10	10	50	50	0	30	10	0
AR2-13	10	20	10	50	50	0	65	30	0
AR2-14	10	20	5	75	50	0	40	10	0
AR2-15	10	10	5	90	90	0	70	10	0
AVERAGE	25	51	10	73	73	0	55	37	0

Graph 1: Percent Control Observed at Auburn Ravine II Canal

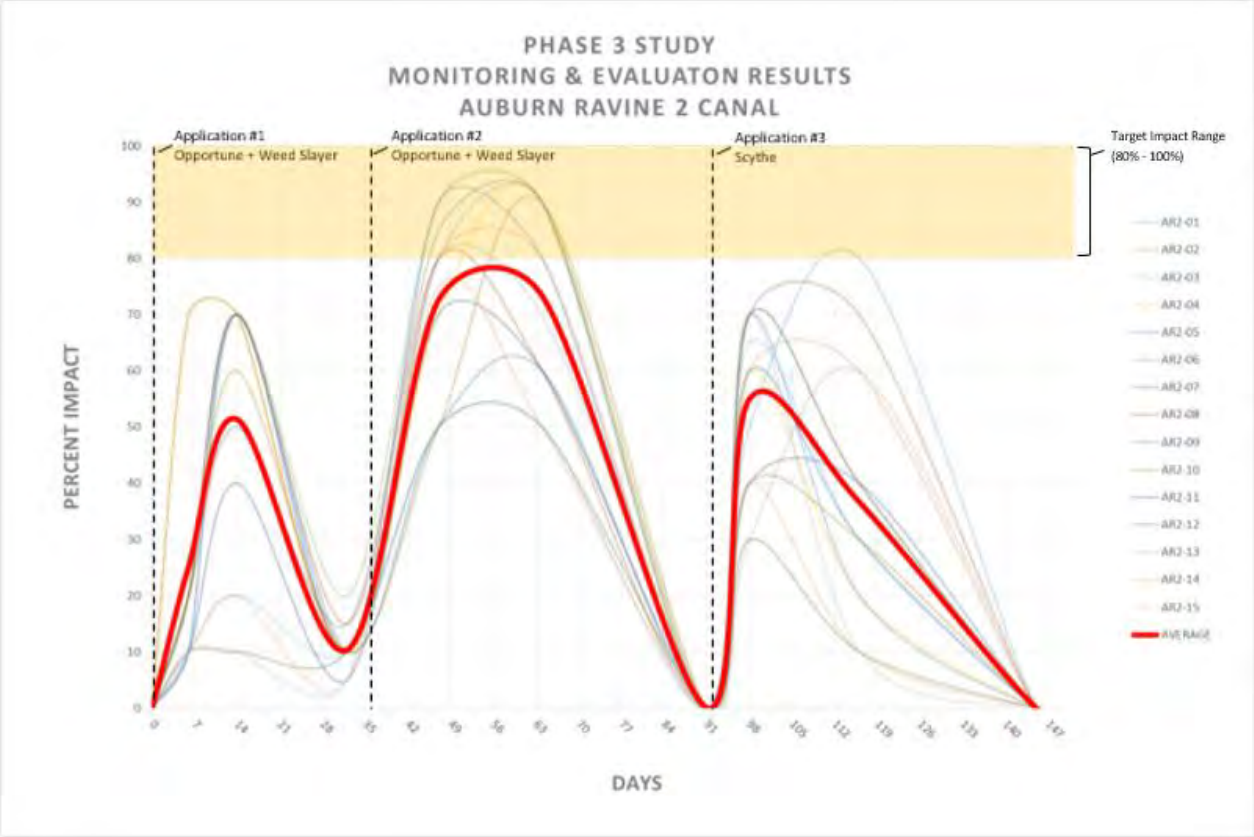
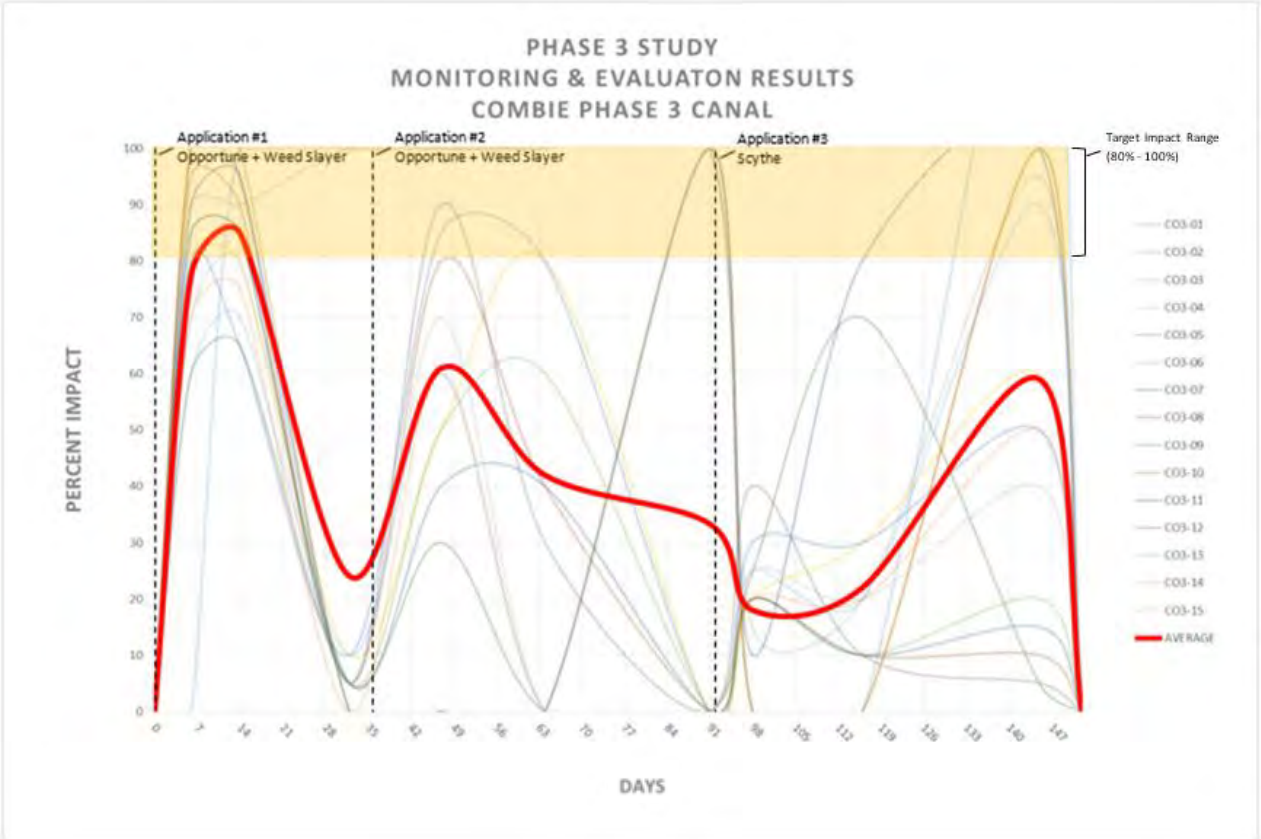


Table 9: Percent Control Observed at Combie Phase III Canal

	DATE								
PLOT	**Dec. 11, 2019**	**Dec. 19, 2019**	**January 6, 2020**	**January 21&22, 2020**	**February 7, 2020**	**March 5, 2020**	**March 12, 2020**	**March 30, 2020**	**April 28, 2020**
CO3-01	100	100	100	0	100	100	0	0	100
CO3-02	100	100	100	0	100	100	0	0	100
CO3-03	90	90	100	0	100	100	15	20	95
CO3-04	80	80	10	50	80	0	20	30	60
CO3-05	80	65	10	85	80	0	30	30	50
CO3-06	85	85	5	50	60	0	20	10	20
CO3-07	85	85	5	40	40	0	20	10	15
CO3-08	95	90	5	80	40	0	20	10	10
CO3-09	100	95	5	90	30	0	40	10	5
CO3-10	100	100	0	0	0	100	0	0	100
CO3-11	90	95	0	0	0	100	10	80	100
CO3-12	60	65	5	30	0	0	25	70	5
CO3-13	60	70	10	60	0	0	25	20	90
CO3-14	70	75	0	60	0	0	20	20	50
CO3-15	70	80	5	70	0	0	25	20	40
AVERAGE	84	85	24	41	42	33	18	22	56

Graph 2: Percent Control Observed at Combie Phase III Canal



RESULTS AND DISCUSSION

The Phase 3 Study has provided useful data on the efficacy of the alternative herbicides when applied across a greater application area. The data collected from the Phase 3 Study also provided an understanding of the trend in vegetation responsiveness to the alternative herbicide application. Understanding the trend in vegetation response is necessary in forecasting control, developing an application plan and schedule that meets control thresholds, support water quality and health, reliable delivery to customers, employee safety and wildfire prevention.

In reviewing the data set and graph for each application location, the general trend in data showed three distinct vegetation response peaks at both Auburn Ravine II Canal and Combie Phase III Canal test locations. In further review of the Combie Phase III data, an unanticipated response peak appeared to occur towards the end of the study period rather than the anticipated response immediately after the third application. After further investigation and review of the data, it appears that the Combie Phase III test site was likely exhibiting vegetation control influence from prior years' non-study related pre-emergent applications.

Although the Phase 3 alternative herbicide applications did not result in average impact ranges within target impact ranges (80% - 100%) supportive of water quality and health, reliable delivery to customers, employee safety and wildfire prevention – a modified protocol with increased application frequency may demonstrate and possibly sustain results of vegetation response in the target impact range. An increased application frequency will result in increased demand on resources including material and labor that must be considered in any future protocol development. In addition, the unavailability of the Opportune alternative herbicide on the market must also be considered in the development of a future test protocol.

RECOMMENDATIONS

Based on the data analysis, it is recommended that the District maintained its research and investigation efforts in identifying and testing alternative vegetation control methods including alternative herbicides and mechanical treatments. Specifically, it is recommended that the District study the use of Weed Slayer and Scythe alternative herbicides under a protocol with increased application frequency to investigate the ability and resources necessary to meet an average target impact range (80% - 100%) supportive of water quality and health, reliable delivery to customers, employee safety and wildfire prevention.

LIST OF APPENDICES

A. Product Labels

OPPORTUNE™

Pre and Post-Emergent Herbicide

For the control of listed annual grasses, broadleaf and sedge weeds.

Active ingredient: Killed, non-viable *Streptomyces acidiscabies* strain RL-110^T cells and spent fermentation media* 17%
Other ingredients: 83%
Total: 100%

* Product contains not less than 4 mg/ml Thaxtomin A.

EPA Reg. No. 84059-12 **EPA Est. No. 84059-MI-001**

KEEP OUT OF REACH OF CHILDREN
CAUTION

FIRST AID	
IF IN EYES:	Hold eye open and rinse slowly and gently with water for 15 – 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
IF INHALED:	Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call poison control center or doctor for treatment advice.
IF SWALLOWED:	Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.
IF ON SKIN OR CLOTHING:	Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 – 20 minutes. Call a poison control center or doctor for treatment advice.
HOT LINE NUMBER	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information.	

CAN BE USED IN ORGANIC PRODUCTION

OMRI LISTED

Marrone Bio Innovations

2121 Second St., Ste. B-107
Davis, CA 95618 USA
info@marronebio.com

NET CONTENTS: _____

OPP-13-01 Lot #:

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION: Causes moderate eye and skin irritation. Harmful if inhaled, swallowed or absorbed through skin. Avoid contact with eyes, skin or clothing. Avoid breathing spray mist. Wear goggles or safety glasses and waterproof gloves. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet. Remove and wash contaminated clothing before reuse.

Personal Protective Equipment (PPE):
Applicators and other handlers must wear:

- Long sleeved shirt and long pants
- Shoes plus socks
- Waterproof gloves

Mixer/loaders and applicators, not in aircraft or enclosed cabs, must wear a filtering face piece respirator meeting NIOSH standards of at least N-95, R-95, or P-95. Repeated exposure to high concentrations of microbial proteins can cause allergic sensitization. Follow the manufacturer's instructions for cleaning/maintaining PPE. If no instructions are available, use detergent and hot water for washables. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS

Users should:

- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Environmental Hazards: For terrestrial uses: Do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exemptions pertaining to the statements on this label about personal protective equipment (PPE) and the restricted entry interval (REI). The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 4 hours.

PPE required for early entry to treated areas (that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil or water), is:

- Coveralls
- Waterproof gloves
- Shoes plus socks

Exception: If the product is soil-injected or soil incorporated, the Worker Protection Standard, under certain circumstances, allows workers to enter the treated areas if there will be on contact with anything that has been treated.

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PRODUCT INFORMATION

OPPORTUNE™ is a selective biological herbicide for use on specific weeds in crops listed. When applied as a pre-emergence herbicide, OPPORTUNE controls annual grasses, broadleaf, and sedge weeds as they germinate. OPPORTUNE is also a selective post-emergent herbicide for control or suppression of broadleaf and sedge weeds infesting labeled crops. The concentrate of OPPORTUNE must be mixed with water and applied as a spray with ground or aerial equipment equipped for conventional herbicide spraying.

Mode of action: OPPORTUNE inhibits cellulose biosynthesis in the meristem of sensitive plant species. When weeds germinate in the treated area, they contact the herbicide and both shoot and root growth stops.

Close scouting and early attention to infestations is highly recommended. Proper timing of application prior to weed germination and/or for targeting newly emerged weeds is important for optimal results.

USE RESTRICTIONS

Do not apply this product through any type of chemigation system.

Do not apply this product to the foliage of any broadleaf (dicotyledon) crop.

Do not apply this product when wind conditions will allow drift to adjacent, broadleaf ornamental plants or to crops.

Do not apply to pasture, grazing lands or grasses grown for hay.

MIXING INSTRUCTIONS
- SHAKE WELL PRIOR TO USE -

Important – Do not add OPPORTUNE to the mix tank before introducing the desired amount of water. Add water to the mix tank. Start the mechanical or hydraulic agitation to provide moderate circulation before adding OPPORTUNE. Add the desired volume of OPPORTUNE to the mix tank and continue circulation. Maintain circulation while loading and spraying. Do not mix more OPPORTUNE than can be used in 24 hours. Use a strainer no finer than 50 mesh in conventional spray systems.

TANK MIXING

This product can be tank mixed in accordance with the most restrictive of label limitations and precautions. No label dosage rates may be exceeded. This product cannot be mixed with any product containing a label prohibition against such mixing.

To ensure compatibility of tank mix combinations they must be evaluated prior to use. To determine the physical compatibility of this product with other products use a jar test. Using a quart jar, add the proportionate amounts of the products to one quart of water with agitation. Add dry formulations first, then flowables, then emulsifiable concentrates last. After thoroughly mixing, let this mixture stand for five minutes. If the combination remains mixed or can be readily be remixed, it is physically compatible. Once compatibility has been proven, use the same procedure for adding required ingredients to the spray tank.

APPLICATION INSTRUCTIONS

Under heavy weed populations, use the higher label rates and/or increase the spray volume to improve coverage.

GROUND APPLICATIONS

Apply OPPORTUNE with quantities of water sufficient to provide uniform coverage of the soil or foliage of targeted weed species. The amount of water needed per acre will depend upon application equipment.

Use sprayers equipped with appropriate nozzles that provide uniform and accurate spray distribution and minimize drift. Nozzle and in-line screens must be no finer than 50 mesh.

Ground Applications (Band)

Apply OPPORTUNE uniformly at the broadcast equivalent rate and volume per acre. To determine these:

$$\frac{\text{band width in inches}}{\text{row width in inches}} \times \text{broadcast rate per acre} = \text{band rate per acre}$$

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AERIAL DRIFT REDUCTION ADVISORY INFORMATION

GENERAL: Avoiding spray drift at the application site is the responsibility of the applicator. The Interaction of many equipment and weather related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions. Where states have more stringent regulations, they should be observed. Note: This section is advisory in nature and does not supersede the mandatory label requirements.

INFORMATION ON DROPLET SIZE: The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply droplets large enough to provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see Wind, Temperature and Humidity, and Temperature Inversions).

CONTROLLING DROPLET SIZE: Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets. Pressure - Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types lower pressure produces larger droplets. When high flow rates are needed, use higher flow rate nozzles instead of increasing pressure. Number of nozzles - Use the minimum number of nozzles that provide uniform coverage. Nozzle Orientation - Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is the recommended practice. Significant deflection from horizontal will reduce droplet size and increase drift potential. Nozzle Type - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.

BOOM WIDTH: For aerial applications, the boom width must not exceed 75% of the wingspan or 90% of the rotary blade. Use upwind swath displacement and apply only when wind speed is 3-10 mph as measured by an anemometer. Use medium or coarser spray according to ASAE 572 definition for standard nozzles or VMD for spinning atomizer nozzles. If application includes a no-spray zone, do not release spray at a height greater than 10 feet above the ground or crop canopy.

APPLICATION HEIGHT: Do not make application at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure to droplets to evaporation and wind.

SWATH ADJUSTMENT: When applications are made with a crosswind, the swath will be displaced downward. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher wind, smaller drops, etc.).

WIND: Drift potential is lowest between wind speeds of 2 - 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. NOTE: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

TEMPERATURE AND HUMIDITY: When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

TEMPERATURE INVERSIONS: Do not apply during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small, suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

SENSITIVE AREAS: The pesticide should only be applied when the potential for drift to adjacent sensitive areas (e.g. residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops) is minimal (e.g. when wind is blowing away from the sensitive areas). Do not allow spray to drift from the application site and contact people, structures people occupy at any time and the associated property, parks and recreation areas, non-target crops, aquatic and wetland areas, woodlands, pastures, rangelands, or animals.

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Olives
Pome Fruit

FOR USE AS A PRE-EMERGENT HERBICIDE ON THE FOLLOWING CROPS FOR CONTROL OF SPECIFIED WEEDS:

Applications must be made prior to transplanting or prior to crop emergence. Do not apply to emerged broadleaf crops except for ground applications made between the rows with the use of shielded applicators.

APPLICATION AND TIMINGS FOR ALL CROPS LISTED

OPPORTUNE will provide effective weed control when applied by ground or aerial equipment and subsequently incorporated into the soil by rainfall, sprinkler irrigation, or mechanical tillage prior to weed seedling emergence from soil.

Pre-plant Surface Applications: For use in minimum tillage or no-tillage production systems, apply OPPORTUNE alone or in tank mixes before planting. Rainfall or sprinkler irrigation after application is required to move this product into the upper soil surface where weed seeds germinate.

Pre-plant Incorporated Applications: Apply OPPORTUNE and incorporate into the upper (1 inch to 2 inches) soil surface prior to planting. Use an implement capable of giving uniform incorporation.

Surface Incorporated Applications: Uniformly apply OPPORTUNE as a broadcast or banded treatment to soil surface underneath established trees and/or in ground areas between tree rows. Incorporate into upper soil surface using either rainfall, sprinkler irrigation, or shallow mechanical incorporation using an implement capable of giving uniform incorporation.

Pre-emergence Surface Applications: Broadcast OPPORTUNE uniformly to the soil surface at planting. Rainfall, sprinkler irrigation, or shallow mechanical incorporation after application is required to move this product into the upper soil surface where weed seeds germinate. If adequate rainfall does not occur and irrigation is not available, use of shallow cultivation or rotary hoeing is required.

Pre-harvest Interval (PHI) = 0 days

Pre-Emergent Crops	Application Method	Product Use per Application	Application Instructions
Artichoke	Ground	8 - 12 quarts per acre	Apply in 10 - 40 gallons of water per acre.
Asparagus			
Bulb Vegetables (garlic, onion and shallots- transplanted sets only)			
Cereal Grains (barley, millet, oats, rice, rye, sorghum, triticale and wheat)			
Citrus (bearing and nonbearing)			
Cole Crops- Brassicas (broccoli, brussel sprouts, cabbage, cauliflower and collards- transplanted sets only)			
Cotton			
Cucurbits (cantaloupe, cucumber, melon, muskmelon, pumpkin, squash, watermelon and zucchini- transplanted sets only)			
Fruiting Vegetables (eggplant, ground cherry, okra, peppers, tomatillo and tomato- transplanted sets only)			
Grapes			
Hops			
Legumes (beans, chick peas, dry beans, garbanzo beans, green beans, lentils, lima beans, peanuts, peas, shell beans, snap beans, soybeans and split peas)			
Olives			
Pome Fruit (apple, crabapple, mayhaw, pear and quince)			

(continued)

Pre-Emergent Crops	Application Method	Product Use per Application	Application Instructions
Root, Tuber and Corm Crops (ginger, ginseng, potato and sweet potato)	Ground	8 - 12 quarts per acre	Apply in 10 - 40 gallons of water per acre.
Stone Fruits (apricot, cherry, nectarine, peach, plum and prune)			
Strawberries (transplanted sets only)			
Tree Nut Crops (almond, beechnut, butternut, cashew, chestnut, filbert, macadamia, pecan, pistachio and walnut)			
Tropical Fruits (avocado, banana, kiwi, mango, papaya, pineapple, plantain and pomegranate)			

Pre-Emergent Target Pests	
Grasses	
Annual ryegrass *(Lolium rigidum)*	Japanese brome *(Bromus japonicas)*
Barnyardgrass *(Echinochloa crus-galli)*	Johnsongrass- from seed *(Sorghum halepense)*
Bluegrass, annual *(Poa annua)*	Jointed goatgrass *(Aegilops cylindrical)*
Brome (*Bromus* spp.)	Junglerice *(Echinochloa colona)*
Canarygrass *(Phalaris arundinaca)*	Lovegrass- from seed (*Eragrostis* spp.)
Crabgrass (*Digitaria* spp.)	Panicum, browntop *(Panicum fasciculatum)*
Crowfootgrass *(Dactyloctenium aegyptium)*	Panicum, fall *(Panicum dichotomiflorum)*
Dallisgrass, seedling *(Paspalum dilatatum)*	Panicum, Texas *(Panicum texanum)*
Foxtail, giant *(Setaria faberia)*	Sandbur, field *(Cenchrus incertus)*
Foxtail, green *(Setaria viridis)*	Signalgrass *(Brachiaria platyphylla)*
Foxtail, yellow *(Setaria glauca)*	Sprangletop, Mexican *(Leptochloa uninervia)*
Goosegrass *(Eleusine indica)*	Sprangletop, red *(Leptochloa filiformis)*
Hairy chess *(Bromus commutatus)*	Witchgrass *(Panicum capillare)*
Itchgrass *(Rottboellia exalta)*	Woolly cupgrass *(Eriochloa villosa)*
Italian ryegrass *(Lolium perenne)*	
Broadleaf Weeds	
Amaranth, Palmer *(Amaranthus palmeri)*	Oxalis, buttercup *(Oxalis pes-caprae)*
Bittercress (*Cardamine* spp.)	Pigweed (*Amaranthus* spp.)
Burweed, lawn *(Soliva pterosperma)*	Purslane, common *(Portulaca oleracea)*
Carpetweed *(Mollugo verticillata)*	Purslane, Florida *(Richardia scabra)*
Chickweed, common *(Stellaria media)*	Ragweed, common *(Ambrosia artemisifolia)*
Chickweed, mouseear *(Cerastium vulgatum)*	Ragweed, giant *(Ambrosia trifida)*
Cudweed (*Gnaphalium* spp.)	Rocket, London *(Sisymbrium irio)*
Filaree (*Erodium* spp.)	Shepardspurse *(Capsella bursa-pastoris)*
Geranium, Carolina *(Geranium carolinianum)*	Speedwell, corn *(Veronica arvensis)*
Henbit *(Lamium amplexicaule)*	Smartweed, Pennsylvania *(Polygonum pensylvanicum)*
Knotweed, prostrate *(Polygonum aviculare)*	Spurge, annual (*Euphorbia* spp.)
Kochia *(Kochia scoparia)*	Spurge, garden *(Euphorbia hirta)*
Lambsquarters *(Chenopodium album)*	Spurge, prostrate *(Chamaesyce humistrata)*
Lespedeza, common *(Lespedeza striata)*	Woodsorrel, creeping *(Oxalis corniculata)*
Mustard (*Brassica* spp.)	Woodsorrel, yellow *(Oxalis stricta)*

FOR USE AS A POST-EMERGENT HERBICIDE ON THE FOLLOWING CROPS FOR CONTROL OF SPECIFIED WEEDS:

Pre-harvest Interval (PHI) = 0 days

Post-Emergent Crops	Application Method	Product Use per Application	Application Instructions
Cereal Grains- excluding rice* (barley, corn, corn grown for seed, field corn, milo, oats, pearl millet, popcorn, proso millet, rye, sorghum, sweet corn, triticale and wheat) * See specific instructions in the following section for rice.	Ground	8 - 12 quarts per acre	Apply in 20 - 40 gallons of water per acre. Applications of OPPORTUNE as a post-emergent herbicide must be targeted against weeds that are 2 inches in height or less. Thorough coverage of weed foliage is necessary for effective control. OPPORTUNE does not have systemic activity. A spreader/sticker or adjuvant which has been approved for growing crops can be added for hard to wet weed species.
Sod farms and grass grown for seed			

Post-Emergent Target Pests	
Broadleaf Weeds (dicotyledons):	
Amaranth, Powell *(Amaranthus powellii)*	Nightshade, hairy *(Solanum sarrachoides)*
Bedstraw, catchweed *(Galium aparine)*	Pickerelweed, heartshape, false *(Monochoria vaginalis)*
Beggarweed, Florida *(Desmodium tortuosum)*	Pigweed, redroot *(Amaranthus retroflexus)*
Buckwheat, wild *(Plygonum convolvulus)*	Pigweed, smooth *(Amaranthus hybridus)*
Buffalo bur *(Solanum rostratum)*	Puncturevine *(Tribulus terrestris)*
Burhead *(Echinodorus cordifolius)*	Purslane, common *(Portulaca oleracea)*
Carpetweed *(Mollugo verticillica)*	Pusley, Florida *(Richardia scabra)*
Cocklebur, common *(Xanthium strumarium)*	Radish, wild *(Raphanus raphanistrum)*
Deadnettle, purple *(Lamium purpurium)*	Ragweed, common *(Ambrosia artemisiifolia)*
Devil's claw *(Proboscidea louisianica)*	Ragweed, giant *(Ambrosia trifida)*
Galinsoga *(Galinsoga parviflora)*	Sesbania, hemp *(Sesbania exaltata)*
Henbit *(Lamium amplexicaule)*	Shepard's-purse *(Capsella bursa-pastoris)*
Horseweed- marestail *(Conyza Canadensis)*	Sicklepod *(Senna obtusifolia)*
Jimsonweed *(Datura stramonium)*	Sida, prickly *(Sida spinosa)*
Kochia *(Kochia scoparia)*	Smartweed, ladythumb *(Polygonum persicaria)*
Lambsquarter, common *(Chenopodium album)*	Smartweed, Pennsylvania *(Polygonum pensylvanicum)*
Mallow, Venice *(Hibiscus trionum)*	Sunflower, common *(Helianthus annus)*
Mustard, wild *(Brassica kaberv)*	Velvetleaf *(Abutilon theophrasti)*
Nightshade, black *(Solanum nigrum)*	Waterclover, (European *Marsilea quadrifolia*)
Nightshade, eastern black *(Solanum ptycanthum)*	

Post-Em Cro
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Container

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Post-Emergent Crops	Application Method	Product Use per Application	Application Instructions
Rice	Ground Aerial	8 - 12 quarts per acre	Apply in 20 – 40 gallons of water per acre by ground or 10 – 20 gallons of water by air. **Water Seeded Rice:** Apply a single post-flood application. Fields must be partially drained to expose weeds prior to application. Target weed species that are at least 70% exposed. Re-flood the field 24 to 48 hours after application of OPPORTUNE. **Dry Seeded Rice:** Apply OPPORTUNE prior to permanent flood. Flood the field 24 – 28 hours after application.

Post-Emergent Target Pests	
Broadleaf Weeds (dicotyledons):	
Redstem (*Ammania* sp.)	Pondweed, American (*Potamogeton nodosus*)
Common waterplantain (*Alisma plantago-aquatica*)	Waterhemp, common (*Amaranthus rudis*)
Arrowhead, California (*Sagittaria montevidensis*)	Waterhemp, tall (*Amaranthus tuberculatus*)
Arrowhead, Gregg (*Sagittaria longiloba*)	Waterhyssops (*Bacopa* spp.)
Naiads- waternymphs (*Najas* spp.)	
Sedges and Rushes	
Sedge, smallflower umbrella (*Cyperus difformis*)	Bulrush, river (*Scirpus fluviatilis*)
Bulrush, ricefield (*Scirpus mucronatus*)	Flatsedge, ricefield (*Cyperus iria*)

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

Pesticide Storage: Store in a cool dry place. Avoid freezing.

Pesticide Disposal: To avoid wastes, use all material in this container by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program (often such programs are run by state or local governments or by industry). Pesticide wastes may be toxic. Improper disposal of unused pesticide, washwater or rinse water is a violation of federal law.

Container Handling: Non-refillable container. Do not reuse or refill this container.

Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling if available, or puncture and dispose of in a sanitary landfill or by incineration. Do not burn unless allowed by state and local ordinances.

To the extent
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in strict accor

Label date:
US Patents N
Opportune™ i
Marrone Bio I

2121 Second
1-877-664-44
www.marrone
info@marronel

MARRONE BIO INNOVATIONS
WARRANTY

To the extent consistent with applicable law, the seller makes no warranty, expressed or implied, of merchantability, fitness or otherwise concerning use of this product. The user assumes all risks of use, storage or handling that are not in strict accordance with the accompanying directions.

Label date:
US Patents No.- (Patent pending in the US)
Opportune™ is a trademark of Marrone Bio Innovations, Inc.
Marrone Bio Innovations' name and logo are registered trademarks of Marrone Bio Innovations, Inc.

2121 Second St., Suite B-107, Davis, CA 95618
1-877-664-4476
www.marronebio.com
info@marronebio.com

SCYTHE®
HERBICIDE

For control of burndown of a broad spectrum of weeds on contact

ACTIVE INGREDIENTS:	% By Wt.
Pelargonic Acid*	57.0%
Related Fatty Acids	3.0%
OTHER INGREDIENTS**	40.0%
	TOTAL 100.0%

*Contains 4.2 pounds of pelargonic acid per U.S. gallon
**Contains petroleum distillates

KEEP OUT OF REACH OF CHILDREN

WARNING – AVISO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

FIRST AID	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. • Call a poison control center or doctor for further treatment advice.
If swallowed	• Call a poison control center or doctor immediately for treatment advice. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.
HOT LINE NUMBER	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-888-478-0798 for emergency medical treatment information. **Note to Physician**: Contains petroleum distillates. Vomiting may cause aspiration pneumonia.	

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS
WARNING

Causes substantial but temporary eye injury. Causes skin irritation. Harmful if inhaled. Harmful if absorbed through the skin. Do not get in eyes, on skin or on clothing. Avoid breathing spray mist. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash clothing before reuse.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Worker Protection Standard (WPS) Uses: Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category E on an EPA chemical resistance category selection chart. Applicators and other handlers who handle this pesticide for any use covered by the Worker Protection Standard (40 CFR Part 170) - in general, agricultural uses are covered - must wear:

- Coveralls worn over short-sleeved shirt and short pants
- Chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber
- Chemical-resistant footwear plus socks
- Protective eyewear (goggles, face shield or safety glasses)

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining personal protective equipment (PPE). If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

NET CONTENTS _____ GALLONS

EPA Reg. No. 10163-325
EPA Est. No.

Gowan®
The Go To Company

Produced For:
Gowan Company
P. O. Box 5569
Yuma, AZ 85366-5569

Non-WPS Uses: Applicators and other handlers who handle this pesticide for any use NOT covered by the Worker Protection Standard (40 CFR Part 170) - in general, only agricultural uses are covered - must wear:

- Long-sleeved shirt and long pants
- Chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber
- Protective eyewear (goggles, face shield or safety glasses)

User Safety Recommendations

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Environmental Hazards

Do not apply directly to water, areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the state or tribal agency responsible for pesticide regulations.

Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protection equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, include:

- Coveralls worn over short-sleeved shirt and short pants
- Chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber
- Chemical-resistant footwear plus socks
- Protective eyewear (goggles, face shield or safety glasses)

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses. Keep unprotected persons out of the treated areas until the sprayed area is dry.

PRODUCT INFORMATION

Scythe® Herbicide is a contact non-selective, broad spectrum, foliar-applied herbicide. This product will only control actively growing emerged green vegetation. It provides burndown of both annual and perennial broadleaf and grass weeds, as well as most mosses and other cryptogams. The degree of burndown and the longevity of control is less when the plants are inactive, mature, or biennial/perennial types.
This product is not translocated. It will burn only those plant parts that are coated with spray solution.
This product is a non-volatile, emulsifiable concentrate. It can be applied through most standard or field type sprayers after dilution and mixing with water in accordance with label instructions. For best results, uniform and complete coverage of target plants is required.
Visible effects on most weeds occur within hours. This product does not damage mature, non-green, woody parts of plants. Cool weather following treatment slows the activity of this product and delays or reduces visual effects.
This product provides no residual weed control. Repeat treatments will be necessary for new plants emerging from seed or regrowth of treated vegetation. Should residual control be desired, use a product labeled for the use situation.

Mixing and Application Instructions

Apply spray solutions in properly maintained and calibrated equipment capable of delivering desired volumes. Avoid spraying or allowing drift to desirable plants. Always clean tank, pump, and line thoroughly with water after use.
Do not apply this product through any type of irrigation system.
Do not apply this product aerially.
Adjust spray droplet size to minimize drift and allow application to the intended exposure area only.

Mixing

This product mixes readily with water. To prepare the spray mixture, fill the mix or spray tank with three-fourths the required amount of water then add the proper amount of this product. Complete filling the mix or spray tank with the balance of water needed. Remove hose from tank immediately after filling to avoid siphoning back into the carrier source. Mix well.
During mixing and application, foaming of the spray solution can occur. A defoaming agent can be added to prevent excessive foaming. If application is intended in or around crops, the defoaming agent must be approved for such use.
Always determine compatibility of companion herbicides and tank additives prior to addition to the spray tank. Determine compatibility by performing a jar test using appropriate quantities of each material and water (see Tank Mixes).
For best results with backpack or other small tank applicators ensure thorough mixing of herbicidal solution at filling and during the spray operation. For sprayers without agitation, mix or shake regularly to maintain suspension. Without agitation, this product separates quickly out of the spray solution.

Boom Equipment
For best control or burndown of annual, biennial or perennial weeds using conventional boom equipment, use the indicated rate of this product in 75 to 200 gallons of spray solution per acre as a broadcast spray. Use lower delivery rates of 10 to 75 gallons per acre of spray solution when this product is used as a tank mix synergist with other foliar products (see Tank Mixes). As the density of weeds increase, increase spray gallonage within the indicated range.

Hand-Held and High-Volume Equipment
Use spray-to-wet applications of this product with knapsack and backpack sprayers, pump-up pressure sprayers, handguns, handwands, and other hand-held spray equipment and vehicle mounted high volume spray equipment. Apply spray solutions of this product to foliage of vegetation to be controlled. For most efficient use of spray mixture, spray all leaf surfaces uniformly and completely to wetness, but not to the point of runoff.

Selective Placement Equipment
Direct the herbicide solution onto weeds using a shielded applicator which employs a physical barrier to shield desirable vegetation from herbicide sprays. When applying this product through a shielded or directed applicator, follow spray volume instructions of the equipment or nozzle manufacturer.

Application Rates
Mix this product in the indicated proportions as listed below and deliver the spray solution through boom, high volume, or hand-held equipment.

Stand Alone Use
Use the following percentage solutions (volume/volume) to deliver 75 to 200 gallons of the spray solution per acre through boom, hand-held equipment, or high volume equipment.
- Use a 3-5% solution for control of annual weeds, mosses and cryptogams. Use the lower rate in the rate range for young, succulent and actively growing weeds and the higher rate for weeds greater than six inches in height or in the flowering stage. Use higher rate for control of mosses, lichens, and other cryptogams on structures and surfaces.
- Use a 5-7% solution for burndown of perennial herbaceous plant, weeds in a later stage of growth and control of sucker growth. Use the highest rate for perennial weeds at or beyond the flower stage or when the plants have "hardened".
- Use a 7-10% solution when maximum vegetative burndown, edging, or foliar trimming is desired.

Repeat application as required to maintain desirable level of weed control and to control plants emerging from seed and underground parts.

Tank Mixes
Tank mixing this product with other pesticides must be governed by the most restrictive label limitations and precautions. Do not exceed any label dosage rates. This product must not be mixed with any product containing a label prohibition against such mixing.
Always predetermine the compatibility of labeled tank mixtures of this product with other products in advance of application by mixing proportional quantities of all products and water in a container and watching for adverse reactions. When tank mixing, add formulations in the following sequence: (1) wettable powders; (2) flowable liquids; (3) emulsifiable liquids; (4) Scythe Herbicide; (5) water soluble liquids; and (6) adjuvants.
This product is synergistic with certain postemergence herbicides. A mixture of this product and glyphosate have shown enhanced speed of top kill and improved control of numerous weed species.
See "Mixing and Application Instructions" section of this label for spray volume, equipment and procedures for tank mixtures.

Scythe plus Glyphosate Herbicides: To enhance the activity of glyphosate-containing herbicides such as Roundup, Rodeo®, Touchdown, Glyphomax® or Glypro® herbicides, and accelerate burndown of target weeds, use the necessary amount of this product to reach a final concentration of 1-3% spray solution plus the labeled rate of the registered glyphosate product (see Rate Table). Lower rates in the rate range will provide less visible burndown effect. When this product is used as an additive and foliar burndown is not expected, mix the necessary amount to reach a final concentration of 0.25-1% spray solution plus the labeled rate of the glyphosate formulation. Adjust rates of both products according to label rates for desired level of control, weeds to be controlled, and conditions at application.

Scythe plus Other Foliar Herbicides: This product can enhance the activity of postemergence herbicides such as Touchdown herbicide and all formulations consisting of cyclohexanedione, sulfonylurea and imidazolinone herbicides when used as a tank mix additive. Use the necessary amount of this product to reach a final concentration of 1-3% spray solution plus the label rate of the companion product (see Rate Table). Lower rates in the rate range will provide less visible burndown effect. When this product is used as an enhancement additive and foliar burndown is not expected, mix the necessary amount to reach a final concentration of 0.25-1% spray solution plus the companion product. Adjust rates of products according to label rates for desired level of control, weeds to be controlled and conditions at application.

Scythe Plus Residual Herbicides: For burndown of vegetation followed by residual control of weeds emerging from seed or underground parts, mix this product with a labeled soil-active herbicide such as all formulations consisting of sulfonylurea, imidazolinone, triazine, dinitroaniline and acylurea herbicides. Follow the use instructions and application rates of the residual companion product plus: (See "Stand Alone" rates)
- 3-5% for annual weeds and vegetation
- 5-7% for perennial herbaceous and late stage annuals
- 7-10% for maximum vegetation burndown

Rate Table

Desired Volume Of Spray Solution (gallons)	Amount of Scythe for Following Percent Solution (Volume/Volume)				
	1%	3%	5%	7%	10%
1	1 1/3 fl oz	4 fl oz	6 2/3 fl oz	9 1/3 fl oz	13 fl oz
2.5	3 1/4 fl oz	9 2/3 fl oz	1 pt	1 3/8 pt	2 pt
5	6 2/3 fl oz	1 1/4 pt	2 pt	1 1/2 qt	2 qt
7.5	9 2/3 fl oz	1 3/4 pt	1 1/2 qt	2 1/4 qt	3 qt
10	13 fl oz	2 1/2 pt	2 qt	2 3/4 qt	1 gal

Use Methods

See the "Use Sites" section of this label to match the method of use with the crop or use situation.

1. **Vegetative Burndown:** General control of weeds for seedbed or site preparation, non-crop and around aquatic sites. Spot treatments may be used in crop and pasture situations.
2. **Directed and Shielded Sprays:** Applications may be made in and around desirable plants when contact of foliage and green bark is avoided.
3. **Prior to Emergence of Plants from Seed, Perennial Rootstocks, Corms and Bulbs:** Ensure applications are made before new growth or crop emerges from soil or damage will occur.
4. **Dormant or Post Harvest Spray:** For control of weeds growing in dormant turf or fields after this commodity has been harvested. Partially green growth will be killed or stunted.
5. **Sucker Control, Pruning and Trimming:** To burn back unwanted basal sucker growth on woody trees and foliage growth on vines, and excessive cane growth in brambles. Apply only to unwanted vegetative parts. Apply before suckers become woody.
6. **Harvest Aid and Desiccation:** To remove leaves of plants prior to harvest and/or burndown of weeds to facilitate harvest. Harvest aid and desiccation uses include applications to root and tuber vegetables, bulb vegetables and cotton only. Applications must be made no later than twenty-four hours prior to harvest (pre-harvest interval = 24 hours).
7. **Structural and Building Applications:** Apply to unwanted vegetation in and around buildings and structures. Application to walks, benches, walls, floors, roofs, or cooling pads for the control of moss and certain algae. A temporary residue or precipitate can result when used on some types of concrete, masonry, brick or stone.

Use Sites

Care must be exercised to avoid contact of spray with foliage of desirable turfgrasses, trees, shrubs, or other desirable vegetation since damage can result. Best results are obtained when applications are made to young succulent weeds and when spray solutions cover all leaf surfaces. Mature, woody weeds are less susceptible. Repeat applications as needed to give desirable levels of weed control.

Select nozzles/pressure combinations that deliver large coarse droplets such as solid cones or flat fans at low pressures, and avoid nozzle/pressure combinations that generate fine particles or mist. If spraying areas adjacent to desirable plants, use a shield to help prevent spray from contacting foliage of desirable plants. Reseeding or transplanting can occur in treated areas as soon as desirable levels of weed control are obtained.

Crop Uses and Use Methods

Use Methods: See the corresponding numbers in the "Use Methods" section under "General Information" for use descriptions and precautions.

Crop Group	Crops	Use Methods
Root Tuber and Perennial Vegetables	Asparagus, artichoke, beet, carrot, ginger, ginseng, horseradish, parsnip, potato, radish, rutabaga, sweet potato, turnip and yam † Harvest Aid and Desiccation uses are approved only for root and tuber vegetables in this crop group.	1,2,3,4,6 †
Bulb Vegetables	Garlic, leek, onion, and shallot	1,2,3,6
Leafy Vegetables	Celery, cilantro, cress, endive, fennel, lettuce, parsley, rhubarb, spinach, Swiss chard	1,2
Cole or Brassica Crops	Broccoli, brussels sprouts, cabbage, cauliflower, collards, kale, kohlrabi, greens (mustard and turnip)	1,2,3
Legume Vegetable	Beans (*Phaseolus* spp. such as: field green, kidney, lima, mung, navy, pinto, snap, and wax beans) (*Vigna* spp. such as: black-eyed, Chinese longbean, cowpea, and southern pea) peas (*Pisum* spp. such as: garden, green, sugar, and snow peas), lentil, and soybean	1,2,3
Fruiting Vegetables	Eggplant, okra, pepper (bell, chili, sweet), pimento, and tomato	1,2,3
Cucurbits and Melons	Cucumber, gourd, muskmelon, cantaloupe, pumpkin, squash, and watermelon	1,2,3
Citrus	Grapefruit, kumquat, lemon, lime, orange, tangerine, and tangelo	1,2
Pome Fruit	Apple, crabapple, pear, and quince	1,2,5
Stone Fruit	Apricot, cherry, nectarine, peach, plum and prune	1,2,5
Small Fruit, Berries, and Grapes	Blackberry, blueberry, boysenberry, cranberry, currant, dewberry, grape (all types), loganberry, olallieberry, raspberry, and strawberry	1,2,3,5
Nuts	Almond, brazil nut, chestnut, filbert, macadamia, pecan, pistachio, and walnut	1,2,5
Tropical and Other Fruit	Avocado, banana, coconut, date, fig, guava, kiwi, mango, olive, persimmon, papaya and pineapple	1,2,5
Field Crops and Cereal Grains	Barley, buckwheat, canola, corn (field, popcorn, and sweet corn), cotton, cowpea, millet, oat, peanut, rice, rye, safflower, sorghum, sugarcane, sunflower, and wheat † Harvest Aid and Desiccation uses are approved only for cotton within this crop group.	1,2,3,6 †
Forages and Pasture Grasses (Forage or Seed)	Alfalfa, clovers, trefoil, vetch, bromegrass, fescue, bluegrass, lespedeza, ryegrass, sudangrass, timothy, range grasses, and crops grown for livestock feed	1,3,4
Herbs & Spices	Anise, basil, caraway, chive, cumin, curry, dill, fennel, oregano, mints, rosemary, sage, savory, sweet bay, tarragon, thyme and wintergreen	1,2,3,4
Beverage and Specialty Crops	Cocoa, coffee, hops, tea, tobacco, and jojoba	1,2,5

Non-Crop Use Sites and Use Methods

Use Methods: See the corresponding numbers in the "Use Methods" section under "General Information" for use descriptions and precautions.

Non-Crop Group	Non-Crop Use Sites	Use Methods
Turf, Flowers, Bedding and Landscape Plants	Turfgrass (maintenance, sod or seed production), bedding plant, flowers, and ornamentals	1,2,3,4,5,6
Trees and Shrubs	Christmas trees, forest and commercial trees, landscape trees, nursery trees or shrubs, and fiber farms	1,2,5
Greenhouse and Indoor Use	All crops, plants, and structures	1,2,3,7
Non-Crop, Industrial, and Public Areas	Farmstead, homestead, fallow land, storage areas, schools, paved areas, rights-of-way (*e.g.*, road, railroad, utilities), parking lots, recreation areas (*e.g.*, athletic fields, campgrounds, golf courses, playgrounds), walks, industrial sites (*e.g.*, lumberyard, tank farms, buildings).	1,2,7
Structures, Buildings, and Walkways	Bench, deck, equipment, floor, roof, wall, walks, and evaporative cooling pads.	7
Dry Aquatic Sites, Dry Drainage Systems and Around Aquatic Sites	Applications must be made 72 hours prior to reflooding of dry aquatic sites. Dry ditches, dry canals, ditch banks, and for use above the water line or after drawdown of agricultural irrigation water and ditch systems, industrial ponds and disposal systems, and impounded water areas.	1,7

Storage and Disposal

Do not contaminate water, feed or foodstuff by storage or disposal.

Pesticide Storage: Keep container tightly sealed when not in use. Store only in original container in a dry place inaccessible to children and pets.

Pesticide Disposal: Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

Container Reuse: Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available.

Triple rinse or pressure rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

FOR 24-HOUR EMERGENCY ASSISTANCE (SPILL, LEAK, OR FIRE), CALL CHEMTREC® (800) 424-9300.
For other product information, contact Gowan Company, LLC or see Material Safety Data Sheet.

NOTICE ON CONDITIONS OF SALE

Important: Read the entire Directions for Use and Notice of Conditions of Sale and Warranty and Liability Limitations before using this product. If terms are not acceptable return the unopened container for a full refund.

Our directions for use of this product are based on tests believed to be reliable. However, it is impossible to eliminate all risk associated with the use of this product. Crop injury, inadequate performance, or other unintended consequences may result due to soil or weather conditions, off target movement, presence of other materials, method of use or application, and other factors, all of which are beyond the control of Gowan Company. To the extent consistent with applicable law, all such risks are assumed by the Buyer and User.

Gowan Company warrants that this product conforms to the specifications on the label when used in strict conformance with Direction for Use, subject to the above stated risk limitations. GOWAN COMPANY MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, GOWAN COMPANY'S EXCLUSIVE LIABILITY FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT WHETHER IN CONTRACT, WARRANTY, TORT, NEGLIGENCE, OR ANY OTHER LEGAL THEORY IS STRICTLY LIMITED TO THE PURCHASE PRICE PAID OR REPLACEMENT OF PRODUCT, AT GOWAN COMPANY'S SOLE DISCRETION.

This product is sold only for uses stated on its label. No express or implied license is granted to use or sell this product under any patent in any country except as specified. Country: United States of America.

Gowan
The Go To Company

Safety Data Sheet
acc. to OSHA

Printing date 07/01/2015 Reviewed on 07/01/2015

*
1 Identification

· **Product identifier**

· **Trade name: SCYTHE® HERBICIDE**
EPA Registration No.: 10163-325
· **CAS Number:** Active Ingredient: Pelargonic acid (57.0%), CAS: 112-05-0
· **Relevant identified uses of the substance or mixture and uses advised against**
· **Sector of Use** Agriculture
· **Application of the substance / the mixture** Agricultural herbicide

· **Details of the supplier of the safety data sheet**
· **Manufacturer/Supplier:**
Gowan Company
P.O. Box 5569
Yuma, Arizona 85366-5569
(928) 783-8844

· **Information department:** sds@gowanco.com
· **Emergency telephone number:**
Chemtrec® Emergency Telephone 24 - Hours: (Spills, leak or fire) Inside U.S. & Canada: (800) 424-9300
Outside the U.S. & Canada: +011 (703) 527-3887

For medical emergency (Prosar®): (888) 478-0798

*
2 Hazard(s) identification

· **Classification of the substance or mixture**

GHS07

Acute Tox. 4 H332 Harmful if inhaled.
Skin Irrit. 2 H315 Causes skin irritation.

· **Label elements**
· **GHS label elements**
The product is classified and labeled according to the Globally Harmonized System (GHS).
· **Hazard pictograms**

GHS07

· **Signal word:** Warning

· **Hazard-determining components of labeling:**
Pelargonic Acid
· **Hazard statements**
Harmful if inhaled.
Causes skin irritation.
· **Precautionary statements**
Avoid breathing dust/fume/gas/mist/vapors/spray
Wear protective gloves.
Specific treatment (see on this label).
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
Call a poison center/doctor if you feel unwell.
If skin irritation occurs: Get medical advice/attention.

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Trade name: SCYTHE® HERBICIDE
EPA Registration No.: 10163-325

(Contd. of page 1)

· **Classification system:**
· **NFPA ratings (scale 0 - 4)**

Health = 2
Fire = 1
Reactivity = 0

HAZARD INDEX:
4 Severe Hazard
3 Serious Hazard
2 Moderate
1 Slight Hazard
0 Minimal Hazard

· **HMIS-ratings (scale 0 - 4)**

Health = 2
Fire = 1
Reactivity = 0

HAZARD INDEX:
4 Severe Hazard
3 Serious Hazard
2 Moderate
1 Slight Hazard
0 Minimal Hazard

· **Other hazards**
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable in US.
· **vPvB:** Not applicable in US.

*

3 Composition/information on ingredients

· **Chemical characterization: Mixtures**
· **Description:** Mixture of the substances listed below with nonhazardous additions.

· **Dangerous components:**		
112-05-0	Pelargonic Acid Skin Corr. 1B, H314	57.0%
64742-65-0	Distillates (petroleum), solvent-dewaxed heavy paraffinic Carc. 1B, H350	<29.7%
64741-88-4	Distillates (petroleum), solvent-refined heavy paraffinic Carc. 1B, H350	<10.5%

*

4 First-aid measures

· **Description of first aid measures**
· **General information:**
Have the product container or label with you when calling a poison control center or doctor, or going for treatment.
You may also contact 1-888-478-0798 for emergency medical treatment information.
· **After inhalation:**
• Move person to fresh air.
• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-

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Trade name: SCYTHE® HERBICIDE
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mouth if possible.
• Call poison control center or doctor for further treatment advice.
After skin contact:
• Take off contaminated clothing.
• Rinse skin immediately with plenty of water for 15-20 minutes.
• Call a poison control center or doctor for treatment advice.
After eye contact:
• Hold eye open and rinse slowly and gently with water for 15-20 minutes.
• Remove contact lenses, if present, after first 5 minutes, then continue rinsing eyes.
• Call a poison control center or doctor for treatment advice.
After swallowing:
• Call a poison control center or doctor immediately for treatment advice.
• Do not induce vomiting unless told to do so by the poison control center or doctor.
• Do not give anything by mouth to an unconscious person.
Information for doctor:
· **Most important symptoms and effects, both acute and delayed** Unknown
· **Indication of any immediate medical attention and special treatment needed**
Contains petroleum distillates. Vomiting may cause aspiration pneumonia.

*
5 Fire-fighting measures

· **Extinguishing media**
· **Suitable extinguishing agents:**
CO_2, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.
· **Special hazards arising from the substance or mixture**
Carbon monoxide (CO)
Carbon dioxide (CO_2)
· **Advice for firefighters**
· **Protective equipment:** Wear self-contained respiratory protective device.

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6 Accidental release measures

· **Personal precautions, protective equipment and emergency procedures**
Wear protective equipment. Keep unprotected persons away.
· **Environmental precautions:**
Do not apply directly to water, areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate.
· **Methods and material for containment and cleaning up:**
Absorb with liquid-binding material (sand, diatomite, acid binders, universal binders, sawdust).
Use neutralizing agent.
Dispose contaminated material as waste according to item 13.
Ensure adequate ventilation.
· **Reference to other sections**
See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for disposal information.

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Trade name: SCYTHE® HERBICIDE
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*
7 Handling and storage

· **Handling:**
· **Precautions for safe handling**
Causes substantial but temporary eye injury. Causes skin irritation. Harmful if inhaled. Harmful if absorbed through the skin. Do not get in eyes, on skin or on clothing. Avoid breathing spray mist. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash clothing before reuse.
· **Information about protection against explosions and fires:** Keep ignition sources away - Do not smoke.

· **Conditions for safe storage, including any incompatibilities**
· **Storage:**
· **Requirements to be met by storerooms and receptacles:**
Keep container tightly sealed when not in use. Store only in original container in a dry place inaccessible to children and pets.
· **Information about storage in one common storage facility:** Store away from foodstuffs.
· **Further information about storage conditions:** Store in dry conditions.
· **Specific end use(s)** No further relevant information available.

*
8 Exposure controls/personal protection

· **Additional information about design of technical systems:** No further data; see item 7.

· **Control parameters**
· **Components with limit values that require monitoring at the workplace:**
The product does not contain any relevant quantities of materials with critical values that have to be monitored at the workplace.
· **Additional information:** The lists that were valid during the creation were used as basis.

· **Exposure controls**
· **Personal protective equipment:**
· **General protective and hygienic measures:**
- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

· **Protection of hands:**

Protective gloves

· **Material of gloves** Chemical-resistant gloves.
· **Penetration time of glove material**
The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.
· **Eye protection:**

Tightly sealed goggles

· **Body protection:**
- Coveralls worn over short-sleeved shirt and short pants
- Chemical resistant-gloves such as barrier laminate, nitrile rubber, or neoprene rubber
- Chemical-resistant footwear plus socks

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Trade name: SCYTHE® HERBICIDE
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• Protective eyewear (goggles, face shield or safety glasses)

*

9 Physical and chemical properties

· **Information on basic physical and chemical properties**	
· **General Information**	
· **Appearance:**	
· **Form:**	Liquid
· **Color:**	Colorless to yellow
· **Odor:**	Waxy
· **Odour threshold:**	Not determined.
· **pH-value at 20 °C (68 °F):**	3.8
· **Change in condition**	
· **Melting point/Melting range:**	Undetermined.
· **Boiling point/Boiling range:**	< 237 °C (< 459 °F)
· **Flash point:**	> 94 °C (> 201 °F)
· **Flammability (solid, gaseous):**	Not applicable.
· **Ignition temperature:**	405 °C (761 °F)
· **Decomposition temperature:**	Not determined.
· **Auto igniting:**	Product is not self-igniting.
· **Danger of explosion:**	Product does not present an explosion hazard.
· **Explosion limits:**	
· **Lower:**	1.2 Vol %
· **Upper:**	Not determined.
· **Vapor pressure:**	Not determined.
· **Density:**	Not determined.
· **Relative density**	Not determined.
· **Vapour density**	Not determined.
· **Evaporation rate**	Not determined.
· **Solubility in / Miscibility with**	
· **Water:**	Dispersible.
· **Partition coefficient (n-octanol/water):**	Not determined.
· **Viscosity:**	
· **Dynamic:**	Not determined.
· **Kinematic:**	Not determined.
· **Other information**	No further relevant information available.

*

10 Stability and reactivity

· **Reactivity**
· **Chemical stability** Stable under normal conditions
· **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications.
· **Possibility of hazardous reactions** No dangerous reactions known.

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· **Conditions to avoid** Excessive heat.
· **Incompatible materials:** No further relevant information available.
· **Hazardous decomposition products:** No dangerous decomposition products known.

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11 Toxicological information

· **Information on toxicological effects**
· **Acute toxicity:**

· LD/LC50 values that are relevant for classification:		
Scythe Herbicide		
Oral	LD50	>5000 mg/kg (rat)
Dermal	LD50	>2000 mg/kg (rabbit)
Inhalative	LC50/4 h	>5.29 mg/l (rat)

· **Primary irritant effect:**
· **on the skin:** Irritating effect
· **on the eye:** Substantial but temporary eye injury.
· **Sensitization:** No sensitizing effects known.
· **Additional toxicological information:**
The product shows the following dangers according to internally approved calculation methods for preparations:
Corrosive
Swallowing will lead to a strong caustic effect on mouth and throat and to the danger of perforation of esophagus and stomach.
Carcinogenic.

· **Carcinogenic categories**

· IARC (International Agency for Research on Cancer)
None of the ingredients are listed.

· NTP (National Toxicology Program)
None of the ingredients are listed.

· OSHA-Ca (Occupational Safety & Health Administration)
None of the ingredients are listed.

*
12 Ecological information

· **Toxicity**
Do not apply directly to water, areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate.
· **Aquatic toxicity:** No further relevant information available.
· **Persistence and degradability** No further relevant information available.
· **Behavior in environmental systems:**
· **Bioaccumulative potential** No further relevant information available.
· **Mobility in soil** No further relevant information available.
· **Results of PBT and vPvB assessment**
· **PBT:** Not applicable.
· **vPvB:** Not applicable.

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· **Other adverse effects** No further relevant information available.

*
13 Disposal considerations

· **Waste treatment methods**
· **Recommendation:**
Wastes resulting from the use of this product must be disposed of on site or at an approved waste disposal facility.

· **Uncleaned packagings:**
· **Recommendation:**
Disposal must be made according to official regulations.
Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available.
Triple rinse or pressure rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.
· **Recommended cleansing agent:** Water, if necessary with cleansing agents.

*
14 Transport information

· **UN-Number**	
· DOT	Not regulated
· ADR, IMDG, IATA	UN1760
· **UN proper shipping name**	
· ADR	1760 Corrosive liquids, n.o.s. (Pelargonic Acid)
· IMDG, IATA	CORROSIVE LIQUID, N.O.S. (Pelargonic Acid)
· **Transport hazard class(es)**	
· ADR, IMDG, IATA	
· Class	8 Corrosive substances
· Label	8
· **Packing group**	
· ADR, IMDG, IATA	II
· **Environmental hazards:**	
· Marine pollutant:	No
· **Special precautions for user**	Warning: Corrosive substances
· Danger code (Kemler):	80

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· **EMS Number:**	F-A,S-B
· **Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**	Not applicable
· **Transport/Additional information:**	
· ADR	
· **Excepted quantities (EQ)**	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml
· IMDG	
· **Limited quantities (LQ)**	1L
· **Excepted quantities (EQ)**	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml
· **UN "Model Regulation":**	US DOT: Non Bulk: Not regulated All Others: UN1760, Corrosive liquids, n.o.s. (Pelargonic Acid), 8, II

*

15 Regulatory information

· **Safety, health and environmental regulations/legislation specific for the substance or mixture**
EPA /FIFRA Information:
This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and for workplace labels of non-pesticide chemicals.

· SARA Title III

· **Section 355 (extremely hazardous substances):**
None of the ingredients are listed.

· **Section 313 (Specific toxic chemical listings):**
None of the ingredients are listed.

· **TSCA (Toxic Substances Control Act):**
All ingredients are listed.

· **Proposition 65**

· **Chemicals known to cause cancer:**
None of the ingredients are listed.

· **Chemicals known to cause reproductive toxicity for females:**
None of the ingredients are listed.

· **Chemicals known to cause reproductive toxicity for males:**
None of the ingredients are listed.

· **Chemicals known to cause developmental toxicity:**
None of the ingredients are listed.

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· **Carcinogenicity categories**

· EPA (Environmental Protection Agency)
None of the ingredients are listed.

· TLV (Threshold Limit Value established by ACGIH)
None of the ingredients are listed.

· NIOSH-Ca (National Institute for Occupational Safety and Health)
None of the ingredients are listed.

· **GHS label elements**
The product is classified and labeled according to the Globally Harmonized System (GHS).

· **Hazard pictograms**
Not applicable

· **Signal word:**
(USA EPA) WARNING

· **Hazard-determining components of labeling:**
Pelargonic Acid

· **Hazard statements**
Causes substantial but temporary eye injury.
Causes skin irritation.
Harmful if inhaled
Harmful if absorbed through skin.
Do not get in eyes or on clothing.
Avoid breathing spray mist.
Wash thoroughly with soap and water after handling.
Remove contaminated clothing and wash before reuse.
Harmful if inhaled.
Causes skin irritation.

· **Precautionary statements**
Avoid breathing dust/fume/gas/mist/vapors/spray
Wear protective gloves.
Specific treatment (see on this label).
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
Call a poison center/doctor if you feel unwell.
If skin irritation occurs: Get medical advice/attention.

· **National regulations:**

· **Information about limitation of use:**
Workers are not allowed to be exposed to the hazardous carcinogenic materials contained in this preparation. Exceptions can be made by the authorities in certain cases.

· **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

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*
16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

· **Department issuing SDS:** Supply Chain
· **Contact:** sds@gowanco.com
· **Date of preparation / last revision** 07/01/2015 / 2
· **Abbreviations and acronyms:**
ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
DOT: US Department of Transportation
IATA: International Air Transport Association
ACGIH: American Conference of Governmental Industrial Hygienists
EINECS: European Inventory of Existing Commercial Chemical Substances
ELINCS: European List of Notified Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent
Acute Tox. 4: Acute toxicity, Hazard Category 4
Skin Corr. 1B: Skin corrosion/irritation, Hazard Category 1B
Skin Irrit. 2: Skin corrosion/irritation, Hazard Category 2
Carc. 1B: Carcinogenicity, Hazard Category 1B
· **Sources** Scythe® is a registered trademark of Gowan Company, L.L.C.
· *** Data compared to the previous version altered.**

PART A

weed Slayer™

controls grass and weeds...naturally

NON-SELECTIVE HERBICIDE

GUARANTEED ANALYSIS:
Active Ingredients:
Eugenol 6%
Inert Ingredients:
Water and Molasses : 94%

PRODUCT INFORMATION
WEED SLAYER is a unique broad spectrum natural herbicide made from a blend of Part A (Eugenol an essential oil of Clove and molasses) and Part B (a strong natural and proprietary bio surfactant)
WEED SLAYER can be applied to control grass and weeds. Results are normally seen in less than a week but can take up to 10 to 14 days. Residuality can be expected to last for several weeks but should not affect new crops.

DIRECTIONS FOR USE:
Mix **32 ounces** of **PART A per acre** and **32 ounces** of **PART B per acre** into 25 gallons and up to 50 gallons of water per acre. **Make sure to agitate** and empty every jug thoroughly. When applying , make sure to protect all desirable crop or plants from overspray as **WEED SLAYER** will affect them. **SHAKE BEFORE USE.**

WEED SLAYER is exempted from EPA registration under FIFRA 25 (b).

CAUTION: KEEP OUT OF REACH OF CHILDREN

PRECAUTIONS:
Avoid getting in eyes or on skin or clothing. The use of side-shield safety glasses and gloves is recommended. Harmful if swallowed. If skin contact occurs, remove contaminated clothing and wash with large amounts of soap and water. If in eyes, rinse repeatedly with clean water for 15 minutes. Obtain medical attention for any persistent irritation.

CONTAINER DISPOSAL:
Dispose of waste material in accordance with federal, state and local environmental laws and regulations.

STORAGE:
Keep container sealed tightly when not in use. Keep product in a cool location away from direct sunlight. Store in temperatures between 5° C (41° F) **and** 25° C (77° F).

CONDITIONS OF SALE:
Seller warrants that this product conforms to the chemical description on the label thereof and is reasonably fit for purposes stated on the label when used in accordance with directions under normal use and conditions. Crop injury, inefficacy, or other unintended consequences may result from factors, such as weather conditions, presence of other materials, or the manner of use or application, which are beyond the control of seller. In no case shall seller or its affiliates be liable for consequential, special or indirect damages resulting from the use, handling, or shipping of this product. No warranty is expressed or implied, including warranty of merchantability or fitness for a particular purpose.

NET VOLUME / NET WEIGHT:

2.5 US Gal 12.56 kg/27.63 lb

LOT: MMDDAAXXX-#
EXP: MM AA

FOR COMMERCIAL USE ONLY
Manufactured in the USA

From the farm to the table... naturally

MANUFACTURED BY:
Agro Research International LLC
29203 State Road 46
Sorrento, FL 32776
(407) 302 6116
www.agroresearchinternational.com

PART B

weed Slayer™

controls grass and weeds...naturally

NON-SELECTIVE HERBICIDE

GUARANTEED ANALYSIS:
Active Ingredients:
Bio Surfactant 35%
Inert Ingredients:
Water 65%

PRODUCT INFORMATION
WEED SLAYER is a unique broad spectrum natural herbicide made from a blend of Part A (Eugenol an essential oil of Clove and molasses) and Part B (a strong natural and proprietary bio surfactant)
WEED SLAYER can be applied to control grass and weeds. Results are normally seen in less than a week but can take up to 10 to 14 days. Residuality can be expected to last for several weeks but should not affect new crops.

DIRECTIONS FOR USE:
Mix **32 ounces** of **PART A per acre** and **32 ounces** of **PART B per acre** into 25 gallons and up to 50 gallons of water per acre. **Make sure to agitate** and empty every jug thoroughly. When applying , make sure to protect all desirable crop or plants from overspray as **WEED SLAYER** will affect them. SHAKE BEFORE USE.

WEED SLAYER is exempted from EPA registration under FIFRA 25 (b).

CAUTION: KEEP OUT OF REACH OF CHILDREN

PRECAUTIONS:
Avoid getting in eyes or on skin or clothing. The use of side-shield safety glasses and gloves is recommended. Harmful if swallowed. If skin contact occurs, remove contaminated clothing and wash with large amounts of soap and water. If in eyes, rinse repeatedly with clean water for 15 minutes. Obtain medical attention for any persistent irritation.

CONTAINER DISPOSAL:
Dispose of waste material in accordance with federal, state and local environmental laws and regulations.

STORAGE:
Keep container sealed tightly when not in use. Keep product in a cool location away from direct sunlight. Store in temperatures between 5° C (41° F) **and** 25° C (77° F).

CONDITIONS OF SALE:
Seller warrants that this product conforms to the chemical description on the label thereof and is reasonably fit for purposes stated on the label when used in accordance with directions under normal use and conditions. Crop injury, inefficacy, or other unintended consequences may result from factors, such as weather conditions, presence of other materials, or the manner of use or application, which are beyond the control of seller. In no case shall seller or its affiliates be liable for consequential, special or indirect damages resulting from the use, handling, or shipping of this product. No warranty is expressed or implied, including warranty of merchantability or fitness for a particular purpose.

NET VOLUME / NET WEIGHT:

9.45 klL0/ 20.85Lb.

FOR COMMERCIAL USE ONLY

Manufactured in the USA

From the farm to the table... naturally

MANUFACTURED BY:
Agro Research International LLC
29203 State Road 46
Sorrento, FL 32776
(407) 302 6116
www.agroresearchinternational.com

LOT: MMDDAAXXX-#
EXP: MM AA

SAFETY DATA SHEET

WEED SLAYER

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name: Weed Slayer.
Product Use: Broad spectrum, nonselective herbicide.
Supplier: AGRO RESEARCH INTERNATIONAL LLC
Address: 29203 State Road 46.
Sorrento, FL 32776
Telephone: 1 407 302 6116
Emergency phone: 1 407 435 9105
E-Mail: marc@agroresearchinternational.com

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENTS	%	CAS #
Eugenol	0 - 6	97-53-0

SECTION 3: HAZARDS IDENTIFICATION

Toxicological risk classification according to WHO: U product unlikely to present acute hazard.
Physical state: dark brown liquid with a characteristic odor of cloves, noncorrosive and chemically stable in its form liquid.
This material is not a "health hazard" or a "physical hazard" as determined when reviewed according to the requirements of the Occupational Safety and Health Administration Hazard Communication Standard, 20 CFR 1910.1200.

Health hazards:
Eyes: Causes eye irritation, ardency, and redness.
Skin: brief contact with the skin is not toxic. Repeated or prolonged contact will dehydrate skin.
Ingestion: Can cause upper GI tract disturbance.
Inhalation: Can cause sneezing and coughing.

SECTION 4: FIRST AID MEASURES

Eye contact: if you wear contact lenses remove them immediately. Rinse with plenty of water for at least 15 minutes, keeping eyelids open. Seek medical attention if irritation persists.

Skin contact: Immediately wash with water. Remove contaminated clothing and wash before use. Seek medical attention if irritation develops.

Inhalation: if it inhaled, bring the person immediately to take fresh air. Seek medical attention if discomfort persists.

Ingestion: Give plenty of water, never induce vomiting. Seek medical attention if consumed in large quantities.

SECTION 5: FIRE-FIGHTING MEASURES

Flammability of the product: Non-combustible. **Flash Point:** 0

Fire Extinguishing: Non-combustible, use water.

General Information: In the case of a fire, wear breathing apparatus. Avoid direct contact with the product, product mists, and thermal decomposition products, which may produce oxides of carbon, nitrogen oxides and other organic substances.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Use personal protective equipment recommended. Stop the spill immediately. Pump the product into drums for disposal. Wash the affected area with plenty of water. Never return spills in original containers for re-use. For waste disposal, see section 13 of the this MSDS. Do not dump into rivers or lakes, keeping away from drains, surface, and groundwater.

SECTION 7: HANDLING AND STORAGE

Handling: Avoid direct eye contact. Wash thoroughly exposed parts after handling and complies with the recommendations issued by good industrial hygiene practices.

Storage: Store in a clean and dry place. Store in original sealed containers, in a place where the temperature is below 90°F (32°C). Do not store with incompatible materials such as strong oxidizing agents, strong acids, and alkalis. It must be protected against physical damage and properly labeled.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Engineering:
Provide adequate ventilation. Install emergency showers and eye showers close to storage and handling areas.

Personal Protection:
Eye Protection: Use safety glasses with side shields or goggles when handling large quantities.

Skin Protection: Wear clothing and gloves PVC, latex or nitrile gloves during work. Gloves and protective clothing should be worn when working with a prolonged contact in your pure form.

Respiratory Protection: Ventilation should be adequate. In case of insufficient ventilation, wear suitable respiratory equipment.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Liquid
Colour:	Dark brown
Odor:	Characteristic of cloves
Viscosity:	> 5000 cps at 70°F (21°C)
Boiling point (°C)	219°F (104.4°C)
Specific gravity (Water = 1)	≤ 1.46 at 60°F (15.6°C)
Vapor pressure (mm Hg)	Data not available
% Volatile (Wt%)	Data not available
Density (Water = 1)	1.4 at 70°F (21°C)
Solubility in water, fats, and organic solvents	Complete
pH	≤6

SECTION 10: STABILITY AND REACTIVITY

Chemical stability: This product is stable under recommended storage and handling conditions. Stable at normal temperatures and pressure.

Hazardous decomposition products: Excessive heat decomposition can produce carbon and sulfur oxides and other organic substances.

Avoiding conditions: High temperatures or excessive heat above 120°F (49°C).

Incompatibilities: Reactive with strong oxidizing agents, alkalis, and strong acids.

SECTION 11: TOXICOLOGICAL INFORMATION

Information on likely routes of exposure:

Oral effects: Data not available
Skin contact: Data not available
Inhalation effects: Data not available
Eye contact: Data not available
Chronic/Carcinogenicity: Not evidence available
Mutagenicity: Not evidence available
Synergistic Materials: Solvents and soaps.

SECTION 12: ECOLOGICAL INFORMATION

Ecotoxicity: Data not available
Persistence and degradability: Data not available
Bioaccumulative potential: this product is not bioaccumulative

SECTION 13: DISPOSAL CONSIDERATIONS

Dispose of waste in accordance with local regulations. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds.
Empty containers may retain some product residues. This material and its container must be disposed of in a safe manner.
Empty containers should be taken to an approved waste handling site for recycling or disposal.

SECTION 14: TRANSPORT INFORMATION

During charging, transfer, transport, unloading, dissolving, mixing and sampling, it is not dangerous if precautions are taken use disclosed herein.
The transportation of dangerous good act classification for this product is: Not regulated. DOT classification: non-toxic, non-corrosive, chemical NOI, non-hazardous.

SAFETY DATA SHEET

WEED SLAYER

SECTION 15: REGULATORY INFORMATION

FIFRA Requirements:

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) allows for federal control of pesticide distribution, sale and use.

Exemptions for pesticides of a character not requiring FIFRA regulation. The pesticides or classes of pesticides listed in this section have been determined to be of a character not requiring regulation under FIFRA, and are therefore exempt from all provisions of FIFRA when intended for use, and used, only in the manner specified. Eugenol is included on this list.

SECTION 16: ADICIONAL INFORMATION

Date of Issue: October 10th, 2017

Prepared by Agro Research International LLC.

References:

The information contained in this safety data sheet material was obtained from sources believed to be accurate and reliable from a technical point of view. Despite that they have been deployed all efforts to ensure full disclosure of product hazards, in some cases, no data are available, which is declared. Whereas the conditions under which the product is used in practice are beyond the control of the supplier, it is assumed that users of this material have been fully trained according to the standards of industrial safety of each user. No express or implied warranties are given, and the provider is not liable for losses, injuries or consequential damages that may result from using or reliance on information contained herein.

Abbreviations:

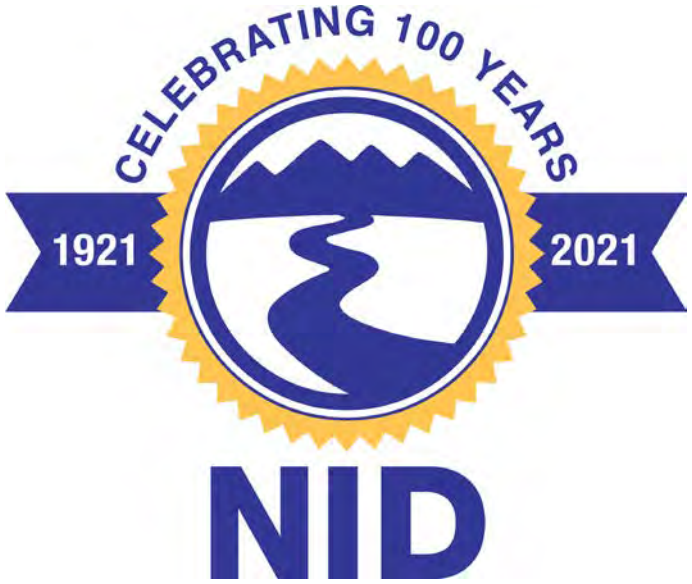
WHO: World Health Organization

CFR: Code of Federal Regulations

NOI: Notice of intent - Chemical safety protocol - notice of intent (NOI)

DOT: Department of transportation.

FIFRA: Federal Insecticide, Fungicide and Rodenticide Act.



Study on Glyphosate Alternatives

Blankinship & Associates, Inc.

Mike Blankinship, Alyssa Nagai

Agenda

1. Introductions
2. Scope
3. IPM/IVM Overview
4. IVM Tools
5. Cost Data Review
6. Glyphosate Discontinuation Survey
7. Take Home Messages
8. Adjourn

1. Introductions

- Nevada Irrigation District
- Blankinship & Associates

2. Scope

- **Identify and evaluate available glyphosate alternatives and their costs**
  - Evaluation of chemical, mechanical, physical and biological alternatives
- **Glyphosate discontinuation experience survey**
  - Survey of California public entities that practice IVM to gather information on the results, impacts, and overall experience of discontinuing glyphosate use

3. Integrated Pest Mgt (IPM)

- "An ecosystem-based strategy that focuses on **long-term prevention** of pests or their damage through a **combination of techniques** such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment."

-University of California Agricultural and Natural Resources Program

3. Integrated Vegetation Mgt (IVM)

- Subcategory of IPM which focuses on the control of plant pests and their damage

3. IVM Tools

Physical/Mechanical Controls

- Kill or damage a pest directly, physically block or prevent pest entry, or make the environment unsuitable for pests
- **Examples:** mowing/weed whacking, hand removal, flaming, steaming, foaming, mulching, soil solarization, weed mats, excavation, soil tillage, prescribed burns

Biological Controls

- The use of natural enemies or other species to manage pests
- **Examples:** grazing, release of beneficial insects/pathogens

3. IVM Tools

Cultural Controls

- Preventative measures that discourage damaging pest populations from developing by reducing a pest's ability to establish, reproduce, disperse, and survive
- **Examples:** irrigation management, nutrient management, sanitation, overseeding/competitive species

Chemical Controls

- The use of herbicides to manage weeds
- **Examples:** pre-emergence herbicides, post-emergence herbicides, organic/ alternative herbicides

3. IVM Tools

Relative Advantages and Disadvantages of Individual Control Tools

- Control tools ranked relative to each other based on professional judgement in terms of:
  - Time effectiveness
  - Cost effectiveness
  - Efficacy
  - Longevity of control
  - Worker safety
  - Public safety
  - Environmental safety
  - Fire safety
  - Public perception
  - Ease of use

Overview of Control Tool Advantages and Disadvantages

Control Category	Control Tool			Effectiveness Score[1]										
				Time Effectiveness[2]	Cost Effectiveness[3]	Efficacy[4]	Longevity of Control[5]	Worker Safety[6]	Public Safety[7]	Environmental Safety[8]	Fire Safety[9]	Public Perception[10]	Ease of Use[11]	Total
Physical/ Mechanical	Mulching			3	3	4	4	4	5	4	4	5	4	40
	Weed Mats			3	3	3	4	4	5	4	5	5	4	40
	Soil Solarization			1	3	4	3	4	5	4	5	4	3	36
	Hand Removal			1	1	4	2	2	5	4	5	5	1	30
	Excavation			2	1	3	3	3	4	3	4	3	2	28
	Soil Tillage			2	2	4	2	3	4	3	4	2	2	28
	Steaming			1	1	3	2	2	4	3	4	4	3	27
	Mowing			4	2	3	2	2	2	2	2	4	3	26
	Prescribed Burns			2	4	2	3	2	1	2	1	3	2	22
	Weed Whacking			2	1	3	2	1	2	2	2	4	2	21
	Flaming			1	2	3	2	1	2	2	1	3	2	19
Biological	Grazing			2	3	3	2	4	5	4	5	5	3	36
	Insect/Pathogen Biocontrol			1	1	1	1	5	5	5	5	3	1	28
Chemical	Pre-Emergent Herbicides			5	4	4	4	3	4	3	5	4	4	40
	Post-Emergent Herbicides	Systemic		5	5	4	5	3	3	3	5	3	4	40
		Contact	Conventional	4	3	4	3	3	3	3	5	3	4	35
			Organic	4	1	2	2	2	3	4	5	4	4	31

Relative Effectiveness Scoring System:

5
Very High/Excellent

4
High/Good

3
Medium/Neutral/ Highly Variable

2
Low/Fair

1
Very Low/Poor

DISCLAIMER

Not all tools are appropriate for all circumstances

In other words, pick the right tool for the job, regardless of score

Example: Grazing

Advantages

- Good public perception
- Can be used in a variety of sites

Disadvantages

- May damage desirable plants
- May spread weed seeds via droppings

Example: Organic Herbicides

Advantages

- Positive Public Perception
- Rapid results
- Often break down quickly in the environment

Disadvantages

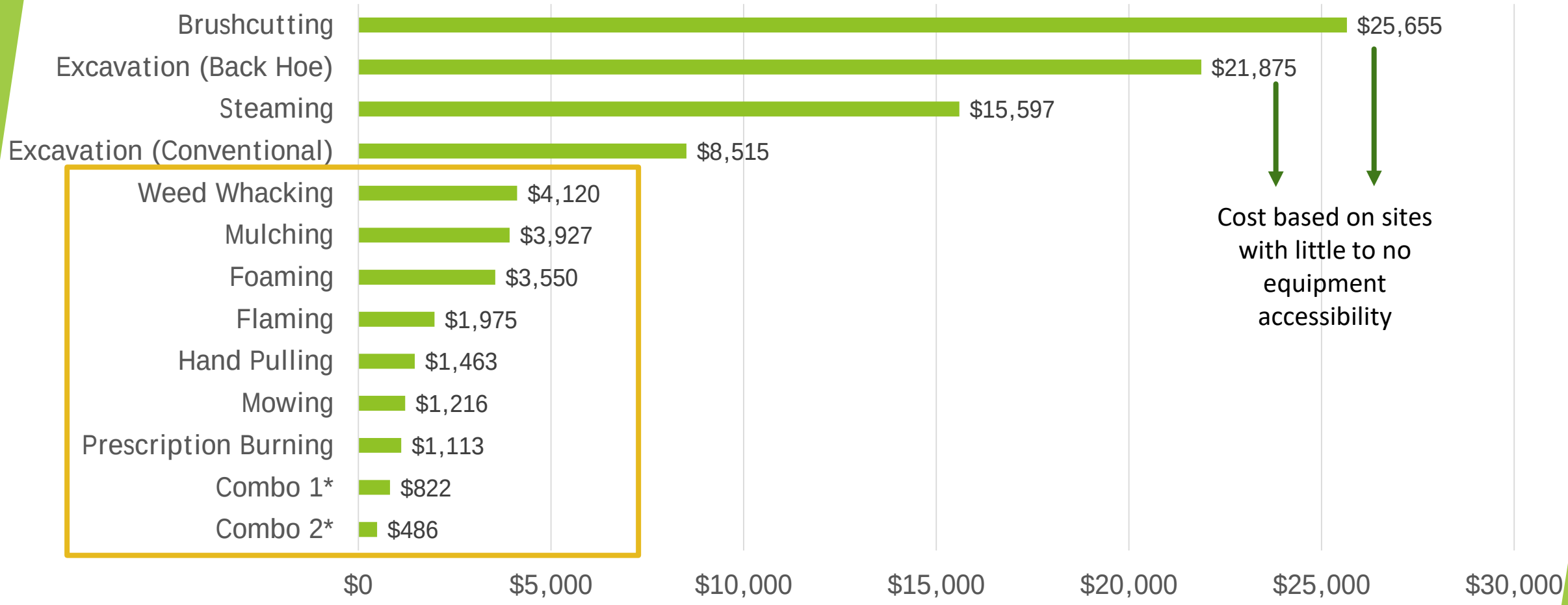
- May have higher acute toxicity
- $$$ to achieve and maintain adequate control

5. Cost Data

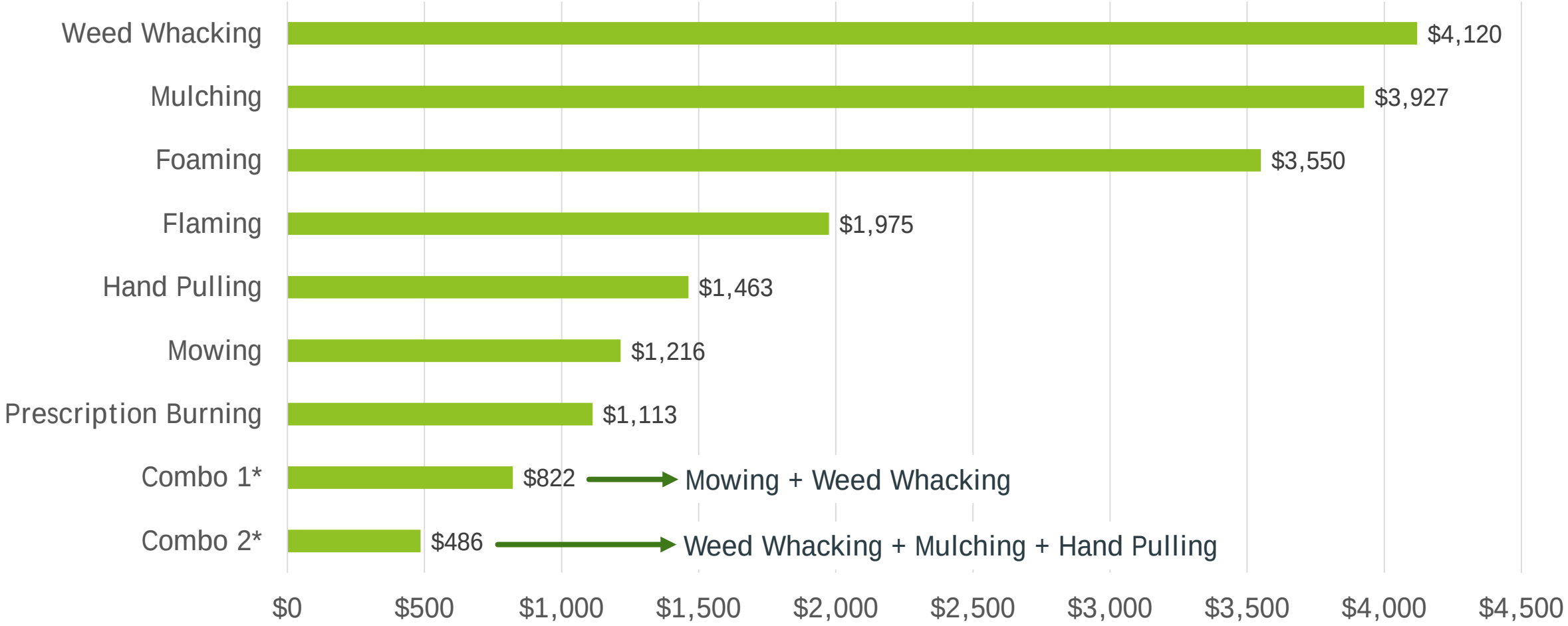
- Cost data for individual control tools gathered from organizations in the vegetation management profession
- Data included cost of labor, equipment, and materials
- Material cost of various herbicide types also gathered

- **Limitations:**
  - Limited datasets available for individual tools and herbicide active ingredients
  - Representative of a variety of site types and conditions
  - Assumptions made and methods use to estimate costs varied, sometimes unknown
  - Older data may not accurately reflect current costs
  - Not “one size fits all”

Average Cost/Acre of Various Physical/Mechanical Control Tools

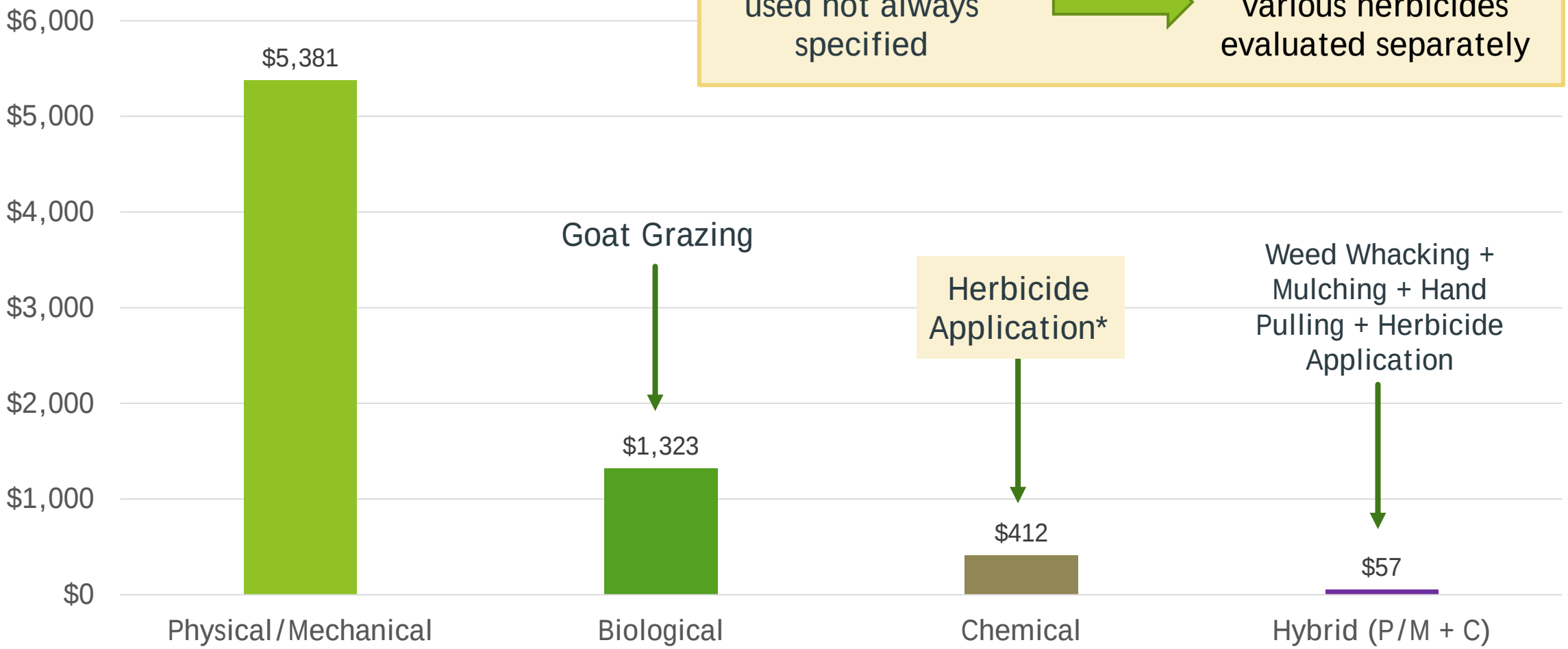


Average Cost/Acre of Physical/Mechanical Control Tools **<$5,000**



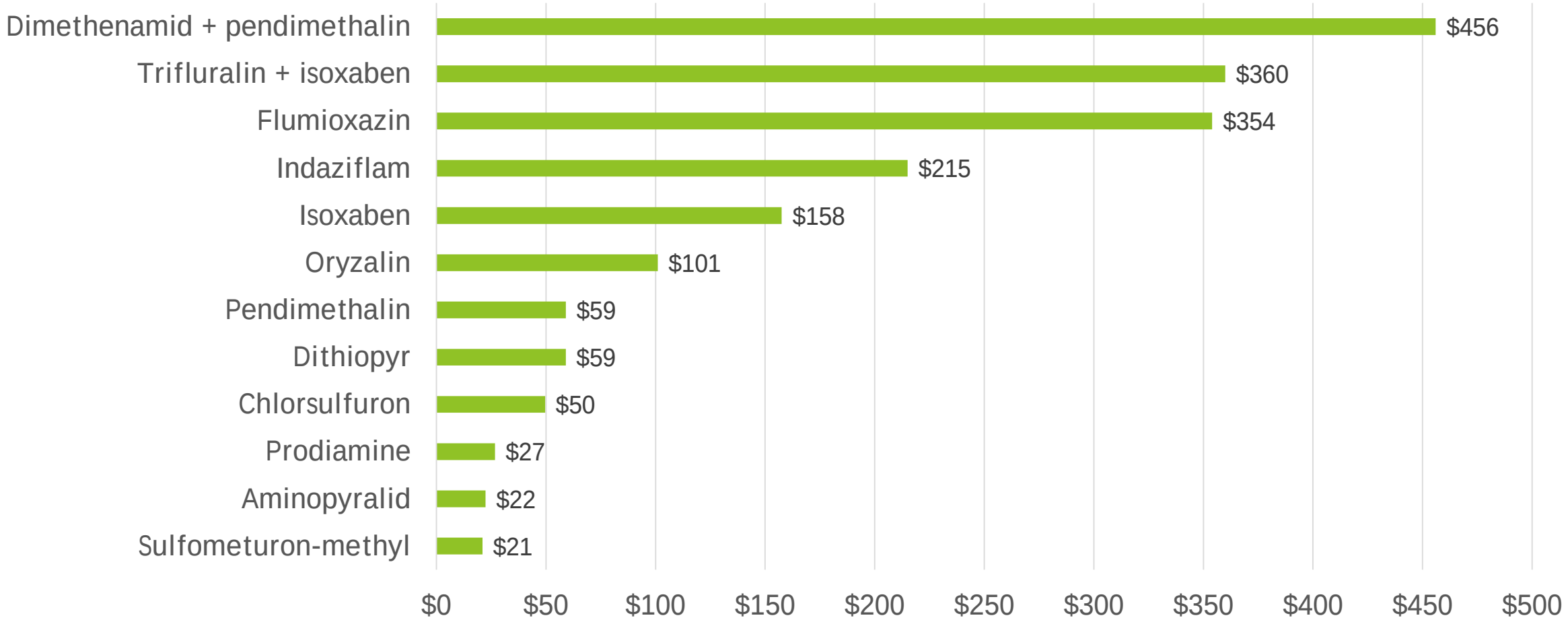
Average Cost/Acre of Control Category Implementation

*Products & rates used not always specified → Material cost of various herbicides evaluated separately



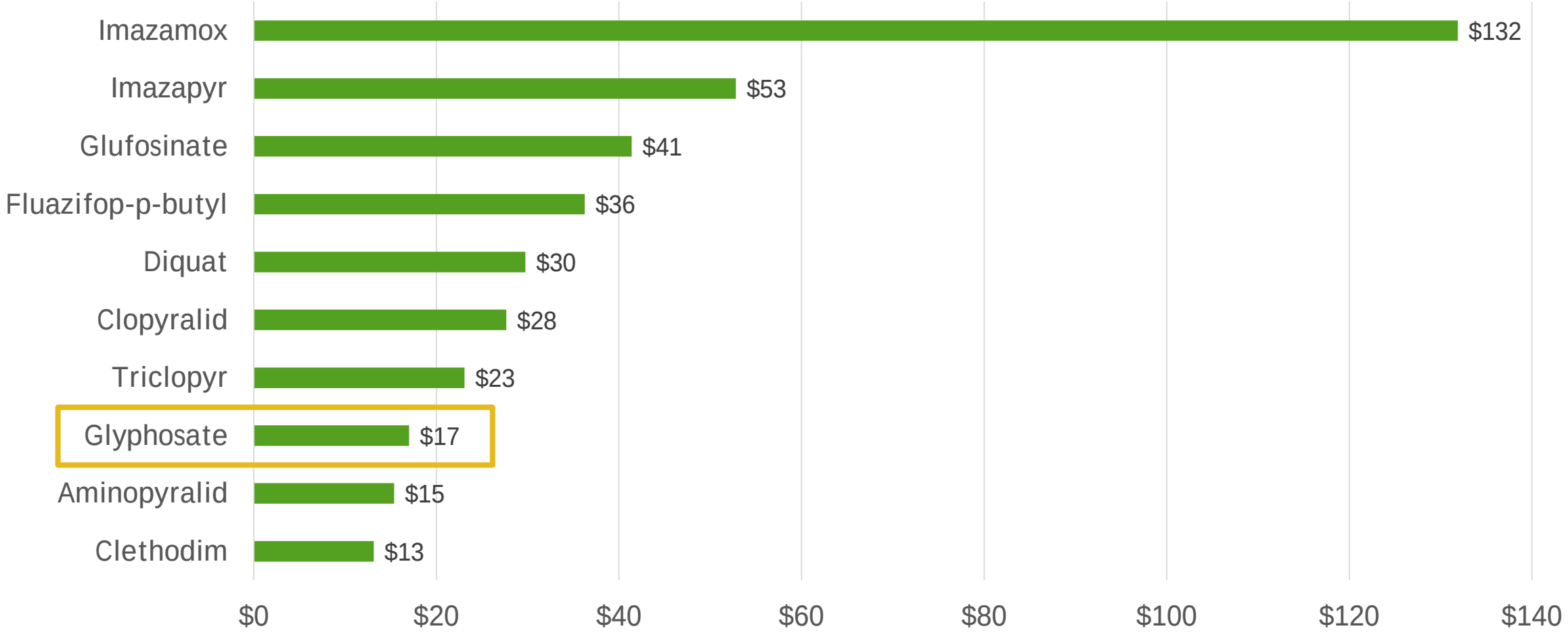
Material Cost Only

Average Cost / Acre of Various Pre-Emergent Herbicides



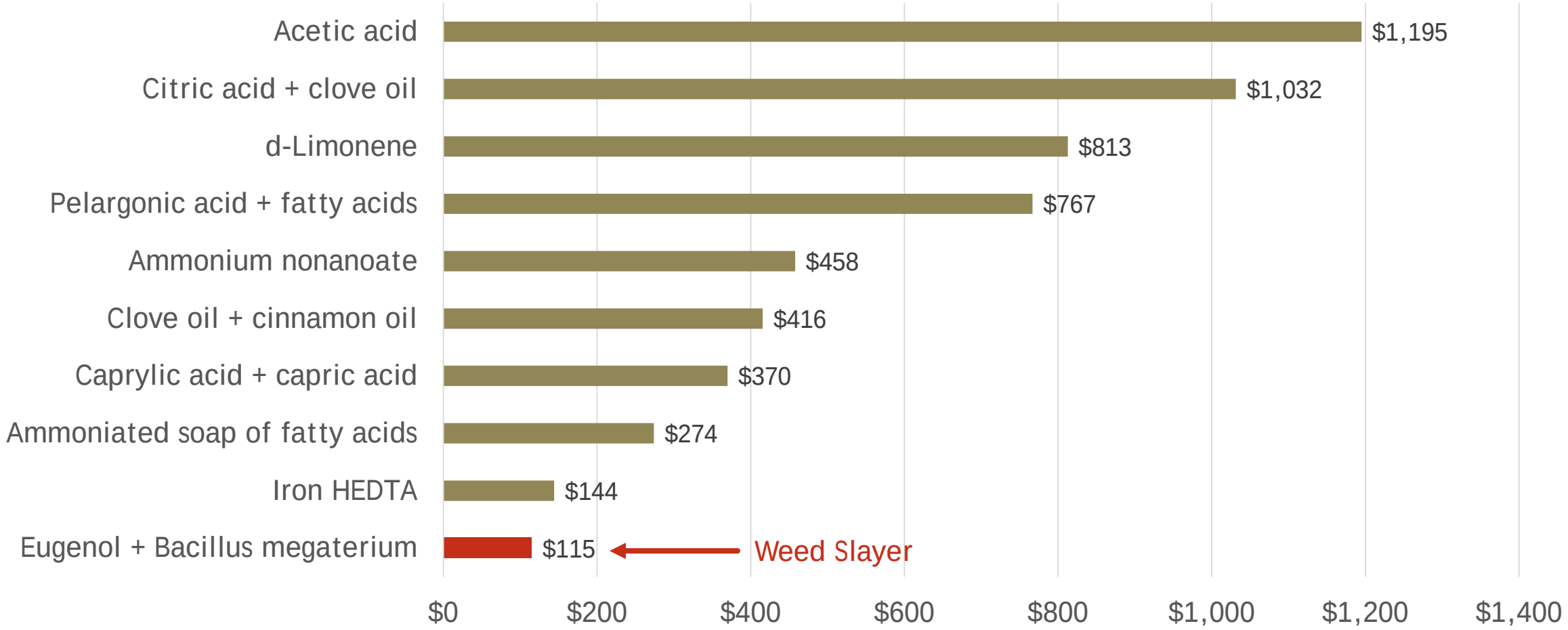
Material Cost Only

Average Cost/Acre of Various Post-Emergent Herbicides



Material Cost Only

Average Cost/Acre of Various Organic/Alternative Herbicides



Weed Slayer: An “Organic” Glyphosate Alternative?

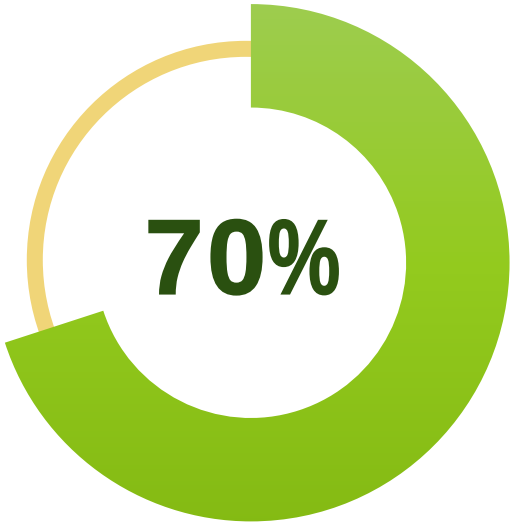
- Stop Use Notice, Statewide Quarantine, and Removal of Sale Order for the product Agro Gold WS issued by California Department of Food and Agriculture (CDFA) on December 4, 2020
- Agro Gold WS is the second part of the two-part organic herbicide product Weed Slayer and was found to contain both glyphosate and diquat
- At this time, the purchase and use of Agro Gold WS alone or as part of Weed Slayer is not permitted

Material Cost Only

Average Cost/Acre Based on Herbicide Type

6. Glyphosate Discontinuation Survey

Not currently using any herbicides



Service levels decreased

Cost of vegetation management increased

Increased implementation of physical/mechanical controls

10 participating entities (30 contacted; no irrigation districts)

7. Take Home Message #1

No “Silver Bullet” Glyphosate Alternative

All control tools have advantages and disadvantages

Tools may be suitable for use in some scenarios but not others

Some tools likely not feasible to implement on a wide scale

7. Take Home Message #2

- Keep IVM toolbox full
- Avoid overreliance on any single tool

Therefore

All control tools have advantages and disadvantages

- Narrow window for effective implementation
- Not registered/intended for use along canal banks
- Primarily used for landscaping

Examples

Tools may be suitable for use in some scenarios but not others

- High upfront/ongoing costs
- Slow
- “Eco friendly” but limited effectiveness

Examples

Some tools likely not feasible to implement on a wide scale

7. Take Home Message #3

- Re-learn weed phenology and control (Glyphosate made us lazy)
- When considering implementation or discontinuing use of individual control tools, remember what you are working to protect
- Strategic use of multiple control tools and **IVM Best Practices** helps support long-term weed management

- What makes the most sense for the site and its management goals?
- Effective for the weed species and its current life stage?
- Which tools have limited vs broad scale use potential due to factors such as available District resources, expected efficacy, and potential for non-target impacts?

- Prevention
- Early detection/rapid response
- Training/Continuing Education
- Adaptive management

7. Take Home Message #4

- When considering implementation or discontinuing use of individual control tools, remember what you are working to protect
- **Strategic use of multiple control tools** and IVM Best Practices helps support long-term weed management

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8. Adjourn

Thank you very much for the opportunity to be of service!