1.0 Purpose of Herbicide Use

Herbicide use is one of the primary methods for managing roadside vegetation, protecting roadway integrity, and improving motorist safety. Herbicide application is used in coordination with physical methods to control vegetation in the right of way and should be used as part of an integrated roadside vegetation maintenance program.

Herbicides are used to:

- Help maintain a clear recovery zone
- Protect roadside infrastructure and pavement integrity
- Control vegetation around roadside features such as guardrails, sign structures, delineators, gores, and headwalls to maintain visibility of hazard markers and reflectors
- Preserve sight lines
- Remove fire fuel accumulations
- Selectively target vegetation that disrupts desirable vegetation communities
- Remove invasive weeds
- Inhibit/retard invasive seedling trees and shrubs

Herbicide Regulations

Herbicide use is regulated by the US Environmental Protection Agency (EPA), which administers the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA dictates the sale, distribution, and use of herbicides. FIFRA requires that herbicides must only be applied according to label directions and by licensed herbicide applicators or operators when working on public lands.

ADOT Vegetation Management Guidelines - Herbicides

The EPA also has jurisdiction over herbicides through the Endangered Species Act (ESA), which is designed to conserve threatened and endangered plants, animals and habitats. EPA evaluates the effect of herbicides on endangered species and habitats and takes this into account in the decision about whether the agency will register a pesticide.

Personnel who apply herbicides along roadways must be licensed by the Arizona Department of Agriculture's (Agriculture) Pesticide Management Division (PMD). Agriculture also enforces federal and state laws governing pesticide use and storage.

The safety of both the applicator and the public is of paramount importance when applying herbicides. Refer to Section 4.0, Safety for additional information.

Approved Vegetation Control Chemicals

Herbicides can be selective (i.e. targeted to specific species) or nonselective (affect any vegetation they come into contact with). They can be applied as broadcast or "blanket" applications or as spot treatments, and can be sprayed directly onto plant foliage or onto bare soil. The active ingredients in herbicides work in different ways:

WHO TO CALL WITH QUESTIONS

Roadside Resources Specialist –ADOT Environmental Planning
Design Landscape Architect – ADOT Roadside Development
Construction Landscape Architect –ADOT Construction Group

District Herbicide and Invasive Species Contacts – see map on the Roadside Resources webpage (http://azdot.gov/business/environmental-planning/biology/roadside-resources)

- **Foliar contact** – herbicide affects only the portion of the plant's foliage it comes into contact with
- **Foliar systemic** – plant foliage absorbs the herbicide and moves (translocates) it around the plant's system; may kill the entire plant
- **Soil active** – applied to the soil, this herbicide moves to the root zone through rainfall, where it is absorbed in the plant's system; may kill the entire plant. Does not affect seeds.
- **Soil active pre-emergent** – this herbicide is applied to the soil and prevents germination of seeds.

Selecting Herbicides

Attachment 1 is a list of herbicides commonly used on ADOT ROW. Herbicides may be added or not recommended for use based on new research, agency requirements, or pesticide laws such as groundwater reporting. The list includes notes on which herbicides are approved for use on BLM and Forest Service land. Other federal agencies and tribal nations have restrictions on the herbicides that may be used on their land. Consult your District Invasive Species/Herbicide Contact (DIS/HC) regarding herbicides to use for specific projects.

Adjuvants

Adjuvants are chemicals that are added to an herbicide spray mix to help the chemical do a better job. Adjuvants include:

- **Surfactants** – help emulsify herbicide so that it mixes well with water; also helps improve the wettability of an herbicide mixture
- **Penetrants** – help the herbicide get through the outer surface of the plant
- **Wetting agents** – help herbicide mixtures cover plant surfaces more thoroughly
- **Spreading and sticking agents** – help make the herbicide spread evenly over the treated surface of the plant and stay there in spite of rain, wind, or inclement weather
- **Drift control agents –** used to create larger droplets to prevent spray drift; used when applying herbicide with winds between 5 and 10 mph, depending on sprayer height, nozzles, pressure, etc**.**

2.0 Planning to Use Herbicides

Determining if an Herbicide is Appropriate

The number one rule for using herbicides is to **Follow the Label**. Do not apply herbicide in a manner that is inconsistent with the label, including application site, method, quantity, and weather conditions. It is against the law to apply herbicide outside the label directions.

Herbicides are a useful tool for vegetation maintenance, but they do have drawbacks. They can:

- Endanger applicators if not properly applied
- Have adverse effects on the environment, crops, livestock, fish, wildlife, and water quality

As a result, herbicide use must be carefully coordinated with land management agencies and private landowners.

On the positive side:

- Use of herbicides rather than mowing or string trimming can increase traveler and worker safety by limiting how often and how long vegetation management staff must be in the right of way or occupying travel lanes.
- Targeted spraying of herbicides is generally less expensive than mowing or other forms of manual vegetation removal.

Whenever herbicides are used, it should only be to the extent necessary to achieve the desired result. Spot spraying should be used over broadcast spraying whenever possible. Careful attention should be paid to the time of the year, plant lifecycles, and weather. If the right herbicides are not applied to the right plants in the right way and at the right time, they will work poorly or not at all—wasting the time, effort, and money required for application.

Cost vs. Benefits

The benefits of using herbicides include:

- Helps limit the need for costly mowing and/or mechanical vegetation maintenance
- Helps control erosion that can damage roadway integrity
- Helps strengthen desirable vegetation communities through selective application
- Helps control invasive weeds

- Reduces fire fuels

Seasonality

To make appropriate decisions about when to apply herbicides, roadside vegetation managers must consider the season of the year, the lifecycle of the plants, and the surrounding ecosystem, in addition to environmental conditions at the time of application, including temperature, anticipated rainfall, and wind. Several considerations relative to applying herbicides include:

- **Vegetation lifecycles.** Foliar herbicides, for example, enter the plant primarily through the leaves, and so must be applied after leaves have emerged (or are "post-emergent"). Some foliar herbicides are best applied immediately after leaves emerge (early POST); some can be applied to established plants (late POST) with good results. Pre-emergent herbicides must be applied to the soil before seeds have germinated to be effective. It is important to understand how herbicide active ingredients work in order to determine at which point in a plant's lifecycle they should be applied.
- **Blooming and seed set**. Blooming plants should not be sprayed with herbicides due to the likely presence of pollinating insects. Herbicide is best applied prior to blooming and seed set. Once a plant has set seed, mechanical methods of control and maintaining seed in the existing area by cleaning machinery is often the best strategy.
- **Temperature.** Warmer temperatures tend to intensify the effect of some herbicides.
- **Anticipated rainfall.** Rain can wash foliar herbicides off plant foliage if the proper adjuvant, like a sticking agent, has not been applied. Soil active and pre-emergent herbicides depend upon rainfall or irrigation to move into the root zones/germination zones of targeted species.
- **Wind.** In some ecozones, windy conditions are seasonal. Wind can cause herbicide to drift outside of the targeted area. An anti-drift agent can help reduce drift under medium wind conditions. Herbicides should not be sprayed when winds are over 10 mph.

3.0 Activity Coordination

Pest Management Division Business License

ADOT has a single statewide PMD Business License (Number 9286). The Roadside Resources Specialist is the primary contact person for ADOT; the District Invasive Species/Herbicide contacts are the primary contact persons for each district. They coordinate herbicide activities and review and approve the e-forms for the applicators within their districts. They are required to demonstrate the following to PMD:

- Where herbicide application records are retained;
- Where personal protective equipment is located;
- Where pesticides are stored; and
- That all applicators are properly certified.

ADOT staff involved in planning, approving, and implementing herbicide use include:

- Maintenance Supervisors
- District Invasive Species/Herbicide Contacts (DIS/HCs)
- District Environmental Coordinators (DECs)
- Landscape Architects
- Roadside Resources Specialist
- Environmental Planning staff

Interagency (ADOT) Coordination

- Vegetation removal and management activities have the potential to damage plants, wildlife, and/or soils; cause the spread of noxious weeds; or may require analysis due to regulations on the use of herbicides. Federal land-managing and regulatory agencies must be consulted when herbicide use is planned on their land.
- The District Invasive Species/Herbicide Contact (DIS/HCs) or Construction/Maintenance Landscape Architect coordinates with land-managing agencies, tribal nations, utilities, and private landowners prior to herbicide applications.
- ADOT Roadside Resources provides support for roadside vegetation management and manages NEPA requirements for vegetation management activities, including the use of herbicides, with external agencies. Roadside Resources provides assistance with obtaining Pesticide Use Proposals (PUPs), which are required for herbicide applications on ADOT ROW across any federal land (including National Parks and Wildlife Refuges as well as BLM and National Forests).
- ADOT Environmental Planning assists with coordination with tribes as part of the Maintenance Work Order process for herbicide treatments.

Pre-Application Activities

- Coordination between the Maintenance Supervisor, the District Invasive Species/Herbicide Contact (DIS/HC); District Environmental Coordinator (DEC); Landscape Architect and/or Roadside Resources should occur as described in the "Before Applying Herbicides" section of Section 3.0, Activity Coordination.
- Coordinate with land-managing agencies, tribal nations, utilities, and private landowners as described in Section 3.0 and Attachment 2, Agency Coordination.
- Survey as needed to determine:
    - Weed density
    - Existing vegetation communities
    - Potential for federal, state, or tribal threatened, endangered, or special-status species (typically performed by a biologist, such as the DEC or Environmental Planning staff)
    - Presence of washes and Waters of the U.S. as designated by the Clean Water Act
- Compliance with required permitting processes, such as:
    - Currently approved Pesticide Use Permit (PUP) if applying herbicide on federal lands
    - Submitting a Notice of Intent under the Clean Water Act Pesticide General Permit spraying within Waters of the U.S.
    - Reporting use of groundwater active herbicides to Agriculture.

4.0 Best Practices for Herbicide Use

Applicator Certifications

ADOT staff who will be applying herbicides are required to pass the National Pesticide Applicator Core and Right-of-Way Category tests offered by PMD and become certified applicators. To earn a National Pesticide Applicator Certification, individuals must submit a completed application, an application fee, a statement and evidence of lawful presence, and pass the Core and at least one category-specific

examination with a score of 75% or higher to become certified in that specific category. Per ARS Section 3-3612, ADOT staff registered with PMD may apply herbicides under the direct supervision of a certified applicator for 90 days before obtaining their own certification. If the certification is not obtained within 90 days of registering with PMD, the person must cease applying herbicides.

In addition, all staff that purchase, use, or supervise the use of restricted-use pesticides (RUPs) as identified by the EPA must be certified applicators. EPA classifies herbicides as RUPs if they pose unreasonable risks to the applicator, other people, or the environment. Picloram and atrazine are both on the RUP list and the PeCoS materials list as of May 2017; however, both lists can be updated annually so it is important to check periodically if any RUPs are being used by ADOT personnel. It is best to avoid use of RUPs and remove them from ADOT inventory. The RUP list can be found on the EPA website.

Training

Staff members are encouraged to study on their own or in study groups with other ADOT employees ahead of taking the PMD test. ADOT has posted training resources for studying for the core and ROW category exams on the Roadside Resources webpage.

There are external 1 and 2-day training courses, such as those offered by Federal agencies, the Southwest Vegetation Management Association, the Arizona Professional Pest Organization and the Southwestern Noxious/Invasive Weed Short Course in Farmington, New Mexico, which may be useful to those studying for the test and also provide Continuing Education Units for those with certifications.

ADOT has internal training courses on use of Herbicide/Spray Trucks (TCH4825 and TCH4826). These courses are only open to certified applicators.

Safety

Before Applying Herbicides

If the pre-application survey indicates the presence of federal threatened, endangered, or state, federal or tribal special-status species, consult ADOT Environmental Planning to determine if an environmental review is needed.

General steps to follow before applying herbicides include:

1. **Notify the District Invasive Species/Herbicide Contact (DIS/HC) at least 10 work days prior to the planned herbicide application.** They will review the following:
    - Current site status to avoid damage to plant communities, spreading noxious weeds, or conflicts with planned mowing
    - Need for coordination with federal, state, agency, and tribal entities
    - Guidance on federal, state, agency, and tribal requirements for herbicide application
    - Whether a PUP is already approved for applications on federal land
2. **Check that weather conditions are acceptable** for applying herbicides
3. **Notify the Maintenance Unit Supervisor** prior to beginning work.

ADOT Vegetation Management Guidelines - Herbicides

Prior to Application

- Learn, keep current with, and strictly adhere to laws and regulations regarding use and disposal of all herbicides
- Inventory and inspect safety equipment before application
- Inspect truck and sprayer for proper operation; check calibration and adjust, if necessary, before leaving yard
- Ensure proper chemical labels and Safety Data Sheets (SDSs)—formerly Material Safety Data Sheets (MSDSs)—are in truck
- Do not transport herbicides in the cab or passenger compartment
- Place safety devices and signs

During Application

- **Follow all label instructions**
- Wear personal protection equipment (PPE), including full-face respirators, rubber boots, gloves, impervious overalls or aprons, and goggles or face shields
- Stop work if weather/environmental conditions change and herbicide drift is occurring.
- Do not allow herbicide to drift into waterways, irrigation canals, and ditches. Do not spray into these areas unless an NOI has been submitted under the Pesticide General Permit.
- Carry spill kits/containment materials in spray vehicle
- Keep a minimum of five gallons of clear water at the work area for emergency cleaning and rinsing
- Keep a detergent at the work site
- If the applicator is contaminated by direct contact with an herbicide, stop all work immediately and initiate first aid and/or clean-up measures

Following application

- Remove safety devices and signs.
- Wash all safety equipment with a detergent solution at the end of each day of use.

Material Storage

- Store herbicides in a locked, secure enclosure such as:
  - Closed vehicle toolbox
  - Closed trailer
  - Building or room
  - Fenced area with a solid fence at least six feet high
  - Truck or trailer with solid sideracks and secured tailgate at least six feet above ground level

- Post warning signs that comply with local ordinances around all storage areas.
- Do not store herbicides for more than 18 months; rotate stock to use the oldest material first.
- Rinse empty containers at least three times, pouring the rinsate into the mix tank. Punch holes in top and bottom of the containers to prevent reuse.
- Dispose of empty containers in secured trash containers. Secure the empty containers if they are transported in a vehicle prior to disposal so that they do not blow out.
- Do not use herbicide containers for any other purpose.

Recordkeeping

All required paperwork, including the PeCoS Crew Work Report and Pesticide eForm Spray Log for maintenance or an Herbicide and Pesticide Application Log for construction, must be completed for every application. Records must include all herbicides applied, including brand name, formulation, EPA registration number, amount and date applied, exact location of application, vehicle calibration, and name, address, and certification number of applicator. Records must be maintained for at least three years.

PMD requires quarterly reporting of use of soil applied pesticides that have been found as contaminants in Arizona streams. The list of pesticides can be found on the PMD website. Use of these herbicides must be reported through the "My PMD for Businesses" section of the PMD website at the same time as the ADOT herbicide e-form is completed.

Additional Best Practices

- Select herbicides and adjuvants based on the target plants to be controlled, extent of the problem, and site considerations
- Use herbicide in coordination with other management techniques, such as mowing
- Always apply in accordance with product labeling
- Use proper application techniques to ensure that herbicides are not applied to non-target or sensitive areas
- Do not apply herbicides if rainfall that will cause runoff is forecast within 12 hours
- Minimize spray drift by applying according to herbicide labels; using nozzles and low pressure; adding an adjuvant when needed, and spraying only when the wind is below 10 mph
- Do not apply herbicides during high temperatures or frozen ground conditions
- Spot-spray weeds rather than broadcast spray in areas where desirable vegetation is also present
- Apply herbicides during the seedling stage and before flowering
- Do not spray when noxious weeds or brush become too mature or tall for satisfactory results; if necessary, mow the infested area and treat the regrowth with herbicide
- Spraying perennial weeds in the fall is more effective for long-term control since the plant is more likely to relocate herbicide to the roots in the fall than in the spring when it is first growing

ADOT Vegetation Management Guidelines - Herbicides

- Inspect the route ahead of time and flag cross culverts, streams, and wetlands so that the sprayer can be shut off with a 30 foot buffer around sensitive areas.
- If applying in or within 30 feet of aquatic habitat, use herbicides and adjuvants approved for aquatic use and follow the requirements of the Pesticide General Permit.
- Clean equipment following use.
- Do not wash herbicide equipment or containers in ditches, streams, ponds, or wetlands; do not allow wash water to flow into any surface waters, including wetlands. The best place to dispose of rinse water from herbicide containers is into the tank. Equipment should only be rinsed in yards with drains connected to a sewer system.
- Clean up spills immediately. For minor herbicide spills notify ADOTWater@azdot.gov or contact the ADOT Water Resources Manager at (602) 712-7947. For major spills in a waterway, contact ADEQ Emergency Response immediately at (602) 771-4163.
- Minimize off-road vehicle travel. Off-road vehicle travel is not allowed during herbicide application on BLM easement unless special permission has been obtained.

ADOT Vegetation Management Guidelines - Herbicides

Attachment 1: Herbicide List

Active Ingredient	BLM[1]	USFS[2]	Selective?	Controls	Pre-Emergent	Post-Emergent	Stream Concern	Mode of Action	Trade Names
2,4-D	Y	Y	Selective	broadleaf		y	n	hormone mimic	Clean Amine
Aminocyclo-pyrachlor			Selective	broadleaf, grasses		y	y	growth regulator	Perspective, Streamline
Aminopyralid		Y	Selective	broadleaf		y	n	growth regulator	Milestone
Bromacil	Y		Non-Selective	broadleaf, grasses	y	y		photosynthesis inhibitor	Hyvar X
Chlorsulfuron	Y	Y	Selective	broadleaf	y	early	y	mitosis inhibitor	Telar
Clopyralid	Y	Y	Selective	broadleaf		Y	y	growth regulator	Stinger, Transline
Dicamba	Y	Y	Selective	broadleaf		y	y	growth regulator/ hormone mimic	Vanquish, Weedmaster
Diflufenzopyr	Y		Non-Selective	broadleaf		y		auxin transport inhibitor	Overdrive
Diquat	Y		Non-Selective	aquatic broadleaf		y	n	photosynthesis inhibitor	Spectracide
Diuron	Y		Non-Selective	broadleaf	y	y	y	photosynthesis inhibitor	Karmex, Diuron
Fluridone	Y		Non-Selective	submerged aquatic broadleaf		y	n	carotenoid synthesis inhibitor	Sonar, Avast
Fluroxypyr		Y	Selective	broadleaf		y	n	hormone mimic	Vista
Glyphosate	Y	Y	Non-selective	all		y	n	protein inhibitor	Roundup, Honcho, Rodeo
Hexazinone	Y		Non-selective	woody		y		photosynthesis inhibitor	Velpar
Imazapic	Y	Y	Rate Selective	all	m	y		amino acid inhibitor	Plateau
Imazapyr	Y	Y	Non-selective	all	y	y	n	protein inhibitor	Habitat, Arsenal
Indaziflam			Selective	broadleaf, grasses	y	y	y	cellulose biosynthesis inhibitor	Esplanade
Isoxaben		Y	Selective	broadleaf	y		n	disrupts root development	Gallery
Metsulfuron-methyl	Y	Y	Selective	broadleaf		y		protein inhibitor	Escort, Ally
Pendimethalin		Y	Non-selective	broadleaf, grasses	y		n	mitosis inhibitor	Pendulum
Picloram	Y	Y	Rate Selective	broadleaf		y	y	growth regulator	Tordon
Prodiamine			Selective	broadleaf, grasses	y			seedling growth inhibitor	Evade
Sethoxydim		Y	Selective	grasses		y	n	amino acid inhibitor	Poast
Sulfometuron-methyl	Y	Y	Non-selective	broadleaf, grasses	y	y	y	amino acid inhibitor	Oust
Tebuthiuron	Y	Y	Selective	woody vegetation	y	y	y	photosynthesis inhibitor	Spike
Triclopyr	Y	Y	Selective	woody, perennial broadleaf		y	n	growth regulator	Garlon, Remedy, Redeem

Notes

[1] Approved in the BLM-ADOT Herbicide Environmental Assessment (2015)

[2] Approved in the USFS Region 3-ADOT Vegetation Management Environmental Assessment (2003); not all National Forests have approved this full list of herbicides in their separate Forest herbicide NEPA documents

ADOT Vegetation Management Guidelines - Herbicides

Attachment 2: Emergency Contacts

Herbicide Spills

- Contact ADOT Emergency Response through the Traffic Operations Center.
- See Policy SAF 18.03 for general response guidelines.

Poisoning Concerns

- Association of Poison Control Centers 800-222-1222
- National Pesticide Info. Center 800-858-7378

Attachment 3: Agency Coordination

Federal Agency Coordination

Herbicide use on federal lands requires an approved Pesticide Use Proposal (PUP). In addition, some federal agencies require the use of specific herbicides on their land. Herbicide use on federal lands may be subject to:

- Conditions of easement deeds
- Memoranda of understanding (MOUs) between the agency in question and ADOT
- Agency guidelines, such as Guidelines for Highways on Bureau of Land Management and U.S. Forest Service Lands
- Agency pesticide use policies
- Planning documents, such as maintenance plans or noxious weed management plans
- NEPA documents

State Agency Coordination

Herbicide use on state lands is subject to the requirements of the Arizona Department of Environmental Quality's Pesticide General Permit. Herbicide use on state land may also be subject to:

- Arizona Native Plant Law
- Agency guidance
- Easement conditions
- Partnering agreements

Table 1 below identifies regulations, requirements, and guidelines that apply when applying herbicides on federal, state, and tribal land**.** Links to many of these resources are available through the ADOT Roadside Resources webpage. Please contact the DIS/HC or Roadside Resources Specialist for additional information and guidance.

ADOT Vegetation Management Guidelines - Herbicides

Table 1. Relevant Regulations, Requirements, and Guidelines for Applying Herbicides

Regulations, Requirements, and Guidelines	Federal Agencies					State Agencies				Tribal Nations *
	National Park Service	BLM	BIA	USFS	USFWS	AZ Dept of Agriculture	AZ Dept of Enviro Quality	AZ Dept of Forestry and Fire Mngmt	AZ State Land Dept	
Pesticide Use Permit (PUP)	•	•	•	•	•					
ADOT-specific NEPA documents completed for herbicide use		•		•						
Guidelines for Highways on BLM and USFS Lands		•		•						
Easement Deeds	•	•	•	•	•				•	•
ADOT – BLM Annual Maintenance Plan		•								
ADOT – Forest Service Annual Maintenance Plan				•						
USFS Pesticide Use Policy				•						
BIA Western Region Integrated Noxious Weed Management Plan			•							
Pesticide General Permit							•			
Water Resources							•			
AZ Dept of Ag, PMD – Licensing for ADOT Herbicide Applicators						•				
AZ Dept of Ag, PMD – Reporting Use of Soil-Applied Pesticides						•				
Forest Health and Invasive Species Coordination								•		
Partnering Agreements*										•
Tribal Ordinances*										•
Tribal Environmental Protection Agency Requirements*										•

* Requirements differ for each tribal nation; Environmental Planning can help with coordination and contacts.

ADOT Vegetation Management Guidelines - Herbicides

Non-Routine Maintenance Activities

Certain non-routine maintenance activities on federal land may have an impact on environmental resources and therefore require NEPA clearance. Check with the appropriate DEC and ADOT Environmental Planning to confirm whether NEPA is required. Examples include projects that might:

- Have a visual impact
- Disturb cultural resources
- Affect a threatened, endangered, or agency-listed species or its habitat

Coordinating with Tribal Nations

Some plants have particular significance in Native American tribal culture, so it's important to coordinate with tribal nations when planning herbicide applications on tribal lands. ADOT will ensure compliance with laws that protect natural and cultural resources. ADOT will coordinate with federal land management and tribal natural resources specialists at the local level when appropriate. Activities on tribal lands may be subject to:

- Conditions of easement
- Partnering agreements
- Tribal ordinances

Land management agencies and Tribes have expectations that certain actions off the pavement will be reviewed by qualified environmental staff such as biologists and cultural resource professionals. When considering herbicide applications on tribal land:

- Consult resource and land management agency maps as needed
- Check with your DEC if planning maintenance actions off the pavement such vegetation removal or ground-disturbing activities to see if additional environmental review is required

Coordinating with the Public

All public inquiries should be referred to ADOT Constituent Services at (602) 712-8111 or the "Contact ADOT" web form at https://apps.azdot.gov/contact_adot/. It can be helpful for the Herbicide Coordinator to provide a monthly spray schedule to their ADOT District Public Information Officer in case of questions. Spraying may be taking place as a result of either maintenance or construction work.

ADOT Vegetation Management Guidelines - Herbicides

Attachment 4: Herbicide Conversion Info

* Always read and follow label information for any herbicide being used *

How to use this reference guide: The below chart gives amount of herbicide needed to obtain different commonly used solution strengths for many of the standard sprayer sizes. Each row represents a different mix amount (in gallons) with each column representing different solution strengths (given in % solution).

Mixing the herbicide: Be sure to wear proper safety gear (usually eye protection, chemical gloves, and long sleeves, but read label information for exact safety gear requirements) when handling, mixing, or applying herbicide.
To mix herbicide, add one-third to one-half of water needed for mix, then add the amount of herbicide denoted in chart and add the remaining amount of water needed to reach desired mix amount. Read the label for information on necessity and rates for additives, such as surfactants and penetrants.

Fluid ounces of herbicide needed for desired solution							
Mix amount	**1%**	**2%**	**3%**	**5%**	**10%**	**15%**	**20%**
1 gallon	1.25	2.5	4	6.5	13	19	26
2 gallons	2.5	5	8	13	26	38	51
3 gallons	4	8	12	19	38	58	77
4 gallons	5	10	15	26	50	77	102
5 gallons	6.5	13	19	32	64	96	128
10 gallons	13	25	38	64 (2 qt)	128 (1 gal)	192 (1.5 gal)	256 (2 gal)
15 gallons	19	38	58	96 (3 qt)	192 (1.5 gal)	288 (1.75 gal)	384 (3 gal)
30 gallons	38	77	115	192 (1.5 gal)	384 (3 gal)	576 (4.5 gal)	768 (3.6 gal)
100 gallons	128 (1 gal)	256 (2 gal)	384 (3 gal)	640 (5 gal)	1280 (10 gal)	1920 (15 gal)	2560 (20 gal)
300 gallons	384 (3 gal)	768 (6 gal)	1152 (9 gal)	1920 (15 gal)	3840 (30 gal)	5760 (45 gal)	7680 (60 gal)

Conversion reference chart

1 gallon = 128 ounces
1 quart = 32 ounces
1 pint = 16 ounces
1 cup = 8 ounces

1 gallon = 4 quarts = 8 pints = 16 cups
1 quart = 2 pints = 4 cups
1 pint = 2 cups