Pesticide Profile for Herbicides Used Within the MEA Utility Integrated Vegetation Management (IVM) Program

Nine herbicide formulations, consisting of seven active ingredients, are included in the MEA integrated vegetation management program. These herbicides have varied modes of action and address different vegetation management requirements and provide options for controlling vegetation along MEA's distribution and transmission rights of way. The following herbicides are used within the MEA utility integrated vegetation management program.

Herbicides, trade names, application rate, control type, and target species for routine vegetation within the MEA system.

Active Ingredient	Trade Name(s) (Equivalent and Subject to Change)	Proposed Application Rate (lbs. ae/acre)	Control Type; Target Species
Herbicides			
Aminopyralid	Milestone, Milestone VM	0.11	Selective pre- and post-emergent; annual grasses and broadleaf weeds. Control of yellow star thistle and other thistle species. Also prescribed in combination with Garlon 3A for greater spectrum of broadleaf weed control. The combination is also effective on numerous brush species
Clethodim	Envoy, Arrow 2 EC	0.25	Selective post-emergent; grass control for annuals and certain perennials, when selective grass control would be necessary to control grass without impact to desirable broadleaf species
Clopyralid	Transline	0.14	Selective post-emergent; broadleaf weeds< thistles and legumes
Fluroxypur	Vista XRT	0.35	Selective broadleaf and brush control; Tank mix with other herbicides for greater spectrum of control
Glyphosate	Aquamaster	4	Non-selective post-emergent; all vegetation
Imazapyr	Polaris and Polaris SP	0.5	Non-selective post-emergent; woody vegetation and perennial invasive grasses
Triclopyr, BEE	Garlon 4 Ultra	2	Selective post-emergent; woody vegetation (cut stumps). Low Volume Basal
Triclopyr; TEA and Choline Salt	Garlon 3A/Vastlan	2	Selective post-emergent; woody vegetation and broadleaf weeds
Surfactants			
Oil-based surfactants	MOC, Hasten, Competitor	N/A	to be used as a surfactant for individual plant treatments; foliar, and as a diluent for imazapyr and triclopyr BEE when performing cut stump or basal applications
Non-ionic surfactant	Induce, Activator 90	N/A	For use with all post-emergent herbicides to improve efficacy

Notes: N/A–not applicable, a.e–acid equivalent, BEE–butoxyethyl ester, lbs.–pounds, TEA–triethylamine

The following provide basic information on the herbicides used in the current MEA IVM Plan Pesticide Summaries

Aminopyralid

Aminopyralid, the active ingredient in Milestone and Milestone VM, is a broadleaf selective herbicide with both pre-emergent and post–emergent activity. This herbicide is used extensively in agriculture and rangeland. The compound is used extensively in open space and wildlife areas for the control of noxious weeds. Milestone cannot be applied to water (SERA 2007; WSSA 2014).

Mode of Action

Aminopyralid is a synthetic auxin. It is absorbed through both the roots and leaves of susceptible plants. It moves readily through the phloem and xylem. It accumulates in the meristematic tissue of both roots and shoots. Little is known about metabolism in susceptible plants. Aminopyralid is rapidly metabolized in tolerant plants such as grasses. Susceptible plants cease growth soon after applications. Over a period of one to three weeks, plants turn from green to reddish yellow to brown. Epinasty at the growing point is also evident. Newer growth becomes mushy and necrotic. Plants treated prior to germination do not emerge. There is little known effect on existing vegetation from soil absorption alone (SERA 2007; WSSA 2014).

Environmental Characteristics

Behavior in Soil: Aminopyralid is loosely bound to soil, and while there is potential for movement, field studies suggested that leaching is not likely, but this depends on the soil chemistry, mineral content, and organic matter (Shaner 2007). The half-life has a range of 14 to 143 days, depending on soil characteristics and temperature. Field studies, including locations in California, produced an average half-life of 32 days (SERA 2007; WSSA 2014).

Behavior in Water: The half-life of aminopyralid in water is approximately eight hours. Photolysis is the primary method of degradation in water (SERA 2007; WSSA 2014).

Toxicological Properties

Wildlife: Aminopyralid is considered practically non-toxic to wildlife; terrestrial, aquatic and invertebrates. Feeding studies involving both quail and ducks resulted in LC_{50} values greater than 5,000 ppm for both species. The LC_{50} values for shrimp, daphnia, bluegill (*Lepomis macrochirus*), and trout were 100 ppm, and for minnows were greater than 120 ppm. Acute toxicity was equally low for honeybees and earthworms (SERA 2007; WSSA 2014).

Human: Aminopyralid is a Category IV herbicide; it is considered practically non-toxic to humans. In studies, both oral and dermal acute toxicities were low with the LD_{50} values for both measures greater than 5,000 mg/kg. Chronic toxicities were low as well. The 24-month dietary NOAEL was 50 mg/kg per day. Studies on long term effects related to cancer, birth defects, mutations, and reproductive impairment revealed no effect at levels greater than 1,000 mg/kg/day (SERA 2007; WSSA 2014).

Clethodim

Clethodim is the active ingredient in the grass-selective herbicides, Envoy and Arrow 2 EC. It is a post-emergent herbicide with many labeled uses, including row crop agriculture. This product cannot be used in water (SERA 2014; WSSA 2014).

Mode of Action

The herbicide is absorbed into leaf tissue in less than one hour, the herbicide activity is immediate, and it is rain-fast immediately. Translocation is mostly through the phloem of the plant. Clethodim accumulates in the growing point of the new tissue. Cessation of growth occurs immediately following application and is first evident in new, actively growing tissue. Chlorosis is evident within one to three weeks. Sheath and stem become mushy and necrotic. Older leaf tissue turns a distinctive red or yellow prior to becoming necrotic. Broadleaf and other species tolerant of clethodim rapidly metabolize the herbicide neutralizing the herbicidal activity (SERA 2014; WSSA 2014).

Environmental Characteristics

Behavior in Soil: Clethodim is weakly bound to the soil; however, leaching is unlikely. It is short-lived in the soil, Clethodim is broken down rapidly via photodegradation and/or hydrolysis. The average half-life is three days on most soil (SERA 2014; WSSA 2014).

Behavior in Water: Minimal data are available regarding degradation in water. However, the rapid rate of degradation via hydrolysis suggests persistence in water is short-lived. The pH will affect the rate of degradation via hydrolysis (SERA 2014; WSSA 2014).

Toxicological Properties

Wildlife: Clethodim is minimally toxic to avian species. Study LD_{50} values for both quail and mallard duck were greater than 2,000 mg/kg. Results of dietary studies (measuring concentration of herbicide on food consumed by the test species) indicated an LC_{50} value of 4,000 mg/kg or greater for both test species. This pesticide is practically non-toxic to insects and similar invertebrates. The oral LD_{50} for bees was greater than 100 micrograms (µg)/bee. The toxicity to aquatic species is somewhat greater. The 96-hour LC_{50} value was 33 mg/kg for sunfish and 18 mg/kg for trout. Aquatic invertebrates are also at greater risk because of the greater toxicity (SERA 2014; WSSA 2014).

Human: Clethodim as Envoy is a Category III herbicide (slightly toxic or relative non-toxic) and requires a “caution” signal word on the label. Acute and chronic toxicities are low, with no expected long-term effects. In studies, the oral LD_{50} value was greater than 1,630 mg/kg and the dermal LD_{50} value was greater than 5,000 mg/kg. A 24-month dietary study determined that the NOAEL was 19 mg/kg. The lowest-observed-adverse-effect level (LOAEL) was 200 mg/kg/day. Clethodim is not a teratogen, mutagen, nor are there any reproductive impacts (SERA 2014; WSSA 2014).

Clopyralid

Clopyralid, the active ingredient in Transline, is a selective post-emergent herbicide. Various formulations are labeled for use in crops, forestry, range, and utility ROW.

Mode of Action

Clopyralid is a synthetic growth regulating herbicide. It stimulates rapid cell elongation which results in a ruptured cell wall and the destruction of the cell wall. Transline is absorbed by the plant rapidly, 97 percent, within 24 hours. Clopyralid translocates readily within the plant. Fifty percent is translocated out of the leaf within 24 hours. It is metabolized slowly in susceptible

plants. Herbicidal activity is evident within 24-to-48 hours. Symptoms include epinasty, chlorosis, and a wilted appearance (SERA 2004a; WSSA 2014).

Environmental Characteristics

Behavior in Soil**:** Clopyralid is weakly adsorbed in soil. It is moderately mobile in soil, particularly in sandy or mineral soil. There are groundwater precautions on the label; field studies have demonstrated that across most studies, clopyralid was not mobile (Washington DOT 2006). The half-life of clopyralid is 40 days. Degradation is mostly microbial and is affected by moisture and soil temperature (SERA 2004a; WSSA 2014).

Behavior in Water: Clopyralid is considered to not persistent in water, although little data is available about the environmental fate in water. It has a short half-life. This coupled with dynamic water conditions result in a rapid degradation of this compound in water (SERA 2004a; WSSA 2014).

Toxicological Properties

Wildlife**:** Transline appears to be relatively non-toxic to wildlife, including avian, aquatic, and invertebrate species. The LD_{50} value for mallard ducks is 1,465 mg/kg. The eight-day dietary studies for both quail and mallard duck established LC_{50} values above 4,000 ppm. Clopyralid technical acid was toxic to honeybees. Forty-eight- and 96-hour exposure studies established LC_{50} values greater than 100 ppm for both fish and invertebrates (SERA 2004a; WSSA 2014).

Human**:** Clopyralid is a Category III herbicide (slightly toxic or relative non-toxic). It has the signal word "caution" on the label. Transline and its active ingredient, clopyralid, are considered practically non-toxic. In studies, the acute toxicity of clopyralid was low. The LD_{50} value was above 5000 mg/kg. Short-term feeding studies established a NOAEL of 150-to -50 mg/kg/day, depending on species. The long-term feeding studies (12 to 24 months) established a NOAEL of 50-to-500 mg/kg/day depending on species. Clopyralid is not a carcinogen, teratogen, mutagen, or reproductive toxin (SERA 2004a; WSSA 2014).

Fluroxypyr

Fluroxypyr, the active ingredient in the herbicide Vista XRT, is a broadleaf selective, post-emergent herbicide particularly successful on many persistent weeds including mare's tail, members of the amaranth family, and members of the Chenopodium family, including those that are resistant to sulfonyl urea herbicides. Labeled use includes rangeland, small grains, and fallow land weed control (SERA 2009; WSSA 2014).

Mode of Action

Fluroxypyr is a synthetic growth regulating herbicide that disrupts cell division. Unique to Fluroxypyr is its ability to affect plant metabolism by disrupting the plant's ability to metabolize nitrogen (essential to plant life) and produce essential plant enzymes. The herbicide is rapidly absorbed into the leaf surface. It is systemic and translocates rapidly through the plant. Root uptake is possible, but soil activity is limited. This herbicide accumulates in the meristematic growing points of the plant. Efficacy is evident within 24 hours with death occurring within two weeks of treatment. Symptoms include epinasty and necrosis of foliar tissue (SERA 2009; WSSA 2014).

Environmental Characteristics

Behavior in Soil: Fluroxypyr is moderately bound to soil. Field dissipation studies indicate little movement. The primary form of soil degradation is microbial. Under anaerobic conditions, the half-life for Fluroxypyr on average is two weeks (SERA 2009; WSSA 2014).

Behavior in Water: Fluroxypyr is not persistent in water. The half-life in ambient water on average is nine days (SERA 2009; WSSA 2014).

Toxicological Properties

Wildlife: Fluroxypyr is considered practically non-toxic to wildlife. The acute oral LD_{50} values for both quail and mallard duck is greater than 2,000 mg/kg. Eight-day feeding studies produced LC_{50} values greater than 5000 mg/kg for both species. There is little risk to insect/invertebrates and aquatic species. The LD_{50} value for the honeybee was greater than 100 µg per bee. Studies found the LC_{50} value for daphnia was greater than 100 mg/L. The LC_{50} value for bluegill was greater than 100 mg/kg. The LC_{50} values for minnows and grass shrimp were also greater than 100 mg/kg (SERA 2009; WSSA 2014).

Human: Fluroxypyr is considered minimally toxic with little risk or irritation to skin and/or eyes. In studies, the oral LD_{50} for the ester formulation was greater than 5,000 mg/kg, and the dermal LD_{50} was greater than 2,000 mg/kg. Long-term exposure presents minimal health risk. The 24-month dietary study using rats indicated the NOAEL at 80 mg/kg/day. There is no evidence of carcinogenicity, teratogenicity, or impacts on reproduction. Fluroxypyr ingested or absorbed into the body is rapidly excreted through the urine unchanged (SERA 2009; WSSA 2014).

Glyphosate

Glyphosate is the active ingredient in Aquamaster or equal, which is a broad-spectrum, non-selective systemic post-emergent herbicide used for control of annual and perennial plants including grasses, sedges, broad-leaved weeds, and woody plants. Glyphosate has no soil activity. It can be used on non-cropland and on various crops. Certain glyphosate formulations, including Roundup Custom and Accord, are suitable for direct application to emergent aquatic vegetation. Glyphosate is used worldwide for the control of exotic plant species in sensitive ecosystems. Glyphosate is one of the most used herbicides in the world, and as a result, is one of the most studied herbicides. Extensive documentation is available regarding its behavior in the environment (SERA 2011a; WSSA 2014).

Mode of Action

Glyphosate is absorbed slowly into the leaves of the target plant and requires six or more hours of rain-free weather to ensure maximum uptake and efficacy. There is no root uptake. Once inside the plant, glyphosate travels readily through the phloem to key activity sites, inhibiting the formation of essential amino acids and plant-specific biochemical processes. Little metabolism of the material occurs in susceptible plants, and this, in part, is why the herbicide is so effective. Symptoms are visible within five days, usually chlorosis and the appearance of a reddish-purple tint in certain species, followed by necrosis within two weeks (SERA 2011a; WSSA 2014).

Environmental Characteristics

Behavior in Soil: Glyphosate rapidly and tightly binds to soil. There is little potential for leaching or runoff due to its extremely high adsorption to soil. As a result, glyphosate becomes inactive as an herbicide upon contact with the soil. Glyphosate is so sensitive to soil that excessive dirt or dust on the leaf at time of application or mixing water that is dirty or high in

mineral content can severely reduce the herbicide's efficacy. Residue can be detected 60 days post-application although there is no herbicidal activity. Glyphosate is degraded via microbial activity. It has a half-life of 47 days, but immediate metabolites are more persistent with a 60- to 90-day half-life (SERA 2011a; WSSA 2014).

Behavior in Water: Glyphosate is very persistent in water with a half-life of 12 days to 10 weeks. The presence of minerals or organic matter in water will tightly bind glyphosate, making it unavailable as herbicide, despite its persistence in the aquatic environment (SERA 2011a; WSSA 2014).

Toxicological Properties

Wildlife: For less toxic formulations of glyphosate, the oral and dietary LD_{50} values for both quail and mallard duck were above 4,500 mg/kg. While technically glyphosate can be toxic to aquatic organisms, Aquamaster is not considered toxic to fish. Studies on bluegill and trout resulted in LC_{50} values greater than 1,000 ppm, and carp studies with LC_{50} values greater than 10,000 ppm. There are some concerns regarding the toxicity of glyphosate-based herbicides due to the internal surfactants used in some formulations to amphibians.

Humans: Glyphosate has the signal word “caution” on the label. Acute toxicity studies indicated that glyphosate was practically non-toxic to humans. The oral and dermal LD_{50} were both greater than 5,000 mg/kg. The oral inhalation LC_{50} value was 3.2 mg/L and the herbicide has no potential for skin or eye irritation (SERA 2011a). The 90-day and 24-month studies produced NOAELs of 1,400 mg/kg and 400 mg/kg/day, respectively, in the most sensitive animals studied. There was no evidence of carcinogenicity, birth defects, or mutations, and there was no impact to DNA (SERA 2011a; WSSA 2014).

Imazapyr

Two herbicide formulations of Imazapyr with distinctly different intended uses would be prescribed: Polaris for foliar applications and Polaris SP for basal applications. Both are non-selective herbicides used for the control of annual and perennial terrestrial grasses, broadleaf herbs, and woody species. Polaris SP is an oil -soluble formulation, while Polaris is an aqueous solution with a label that includes aquatic application. Polaris is used to control riparian and emergent aquatic species. Formulations of imazapyr are used extensively throughout the world in sensitive habitats for the control of invasive species including Arundo, melaleuca, pampas grass, and tamarisk. It is primarily a post-emergent herbicide with limited pre-emergent activity (SERA 2011b; WSSA 2014).

Mode of Action

Imazapyr is rapidly absorbed into the plant by both the root and shoot. It is very mobile in the plant, translocating readily through both the phloem and xylem, inhibiting the synthesis of branched-chain amino acids. Growth is inhibited within hours of application. Symptoms are slow to appear (one to two weeks) and are first observed in the growing point of the susceptible plant. Chlorosis followed by necrosis is observed, and the growing point becomes mushy and is easily removed 60 days after treatment. Susceptible plants metabolize imazapyr slowly, if at all. This persistence allows for translocation throughout the entire plant including the roots, making this herbicide extremely effective on perennial weeds (SERA 2011b; WSSA 2014).

Environmental Characteristics

Behavior in Soil: Imazapyr is weakly bound to soil. Adsorption increases as organic matter and clay content increase. Imazapyr is moderately persistent in soil, but not prone to leaching (Shaner 2007). The half-life of imazapyr ranges from 25 to 145 days, depending on soil type and environmental condition. Microbial degradation is the primary means of dissipation (SERA 2011b; WSSA 2014).

Behavior in Water: Imazapyr is rapidly decomposed in water. The half-life in water is three to four days. The presence of light will reduce the half-life by 50 percent (SERA 2011b; WSSA 2014).

Toxicological Properties

Wildlife: There is little risk to wildlife from the application of either formulation. In studies, Polaris oral LD_{50} values for both quail and duck were greater than 2,000 mg/kg. Eight-day dietary LD_{50} values were greater than 5,000 mg/kg. LC_{50} values from all fish studies were greater than 100 ppm, indicating that imazapyr is non-toxic to those species. The material does not bio-accumulate (SERA 2011b; WSSA 2014).

Human: Both herbicides have the signal word "caution." Acute toxicity tests indicate imazapyr has a low mammalian toxicity and presents little risk to humans. In studies, the acute oral LD_{50} value was greater than 5,000mg/kg and the dermal LD_{50} was greater than 2,000 mg/kg. There is no evidence of eye or skin irritation and there is little risk from inhalation. The NOAEL was greater than 1,500 mg/kg, suggesting long term effects are not likely. Imazapyr is not a carcinogen. It does not cause birth defects, mutations, or reproductive harm (SERA 2011b; WSSA 2014).

Triclopyr

Triclopyr is a broadleaf selective post-emergent herbicide used for control of annual and perennial broadleaf weeds and brush in crop and non-crop sites. It has no herbicidal activity on grass species. There are two distinctly different formulations of triclopyr used commercially as herbicides: triethylamine Choline salt (TEACS) and butoxyethyl ester 5 (BEE). Several TEA CS formulations are labeled for aquatic applications. Garlon 3AVastlan (TEA CS formulation) can be used for terrestrial and aquatic applications. Garlon 4 Ultra (BEE formulation) has terrestrial applications only (slightly toxic or relative non-toxic). Garlon 4 Ultra would only be used for basal applications, and these would be limited.

Mode of Action

Triclopyr is an auxin-mimicking herbicide that affects cell division and expansion. It is transported through the phloem and xylem of the plant and accumulates in the meristematic tissue of the shoots of susceptible plants, accelerating growth resulting in ruptured cell walls. Triclopyr is rapidly metabolized in the plant, more so in tolerant plants than non-tolerant plants. Eighty-five percent of a dose is metabolized within three days. Susceptible plants cease growth soon after applications over a period of one to three weeks. Plants turn from green to reddish-yellow to brown. Epinasty at the growing point is evident. Newer growth becomes mushy and necrotic (SERA 2016b; 2011c; WSSA 2014).

Environmental Characteristics

Behavior in soil: Triclopyr is not tightly adsorbed to the soil, which can be affected by soil organic matter and clay content. The soil half-life is 30 days; depending soil moisture. While

there is potential for soil movement, studies indicate leaching and/or lateral movement in soil is unlikely (SERA 2016b; SERA 2011c; WSSA 2014).

Behavior in water: Triclopyr rapidly degrades in water, mostly by photo degradation, with a half-life of six hours in most conditions (SERA 2016b; SERA 2011c; WSSA 2014).

Toxicological Properties

Wildlife: Both acute and chronic toxicity studies indicate Garlon 3A & Choline Salt are non-toxic to terrestrial wildlife. It is also considered practically non-toxic to fish and aquatic organisms with LC_{50} values for fish ranging from 600 to 891 mg/L. The ester formulation and use of petroleum in the formulation of Garlon 4 makes this formulation less compatible with aquatic and amphibian species. Garlon 4 is considered moderately to highly toxic to aquatic wildlife. LC_{50} values for fish ranged from 0.36 to 1.7 mg/L (SERA 2016b; SERA 2011c; WSSA 2014). Garlon 4 would not be used within 300 feet of perennial streams, lakes, or other water bodies or within 100 feet of intermittent watercourses.

Human: Garlon 3A, a Category I herbicide has the signal word "danger." The "danger" signal word is due to the potential for severe eye irritation from contact with the formulated concentrate. Vastlan has the signal work warning as this formulation presents lass of rick for eye irritation. Garlon 4 Ultra is a Category III herbicide (slightly toxic or relative non-toxic), with the signal word "caution." In studies, the acute toxicity of Garlon 3A was low with LD_{50} values above 2,500 mg/kg for oral ingestion. Potential acute toxicity for dermal absorption and inhalation was slight to moderate. Prolonged exposure to concentrated Garlon 3A can result in skin and/or severe eye irritation. Chronic exposure studies, both 90-day and 22-month, revealed a NOAEL of five mg/kg/day. A decrease in body weight and some impact on kidneys was observed. The studies revealed no evidence of mutations, birth defects, tumors, or reproductive impacts. Garlon 4 Ultra is a Category III herbicide with a "caution" signal word on the label. The acute toxicity was low with the oral LD_{50} value at 1,581 mg/kg. The toxicological profile of Garlon 4 Ultra is similar to that of Garlon 3/Vastlan (SERA 2016b; SERA 2011c; WSSA 2014).

Surfactants

Surfactants, such as Competitor, reduce surface tension and subsequently spread the surfactant across the leaf surface. There is a moderate amount of information about surfactants. The USDA Forest Service completed an extensive risk assessment for the silicone (R-11) class of surfactants (Bakke 2003). Measures of both acute and chronic toxicity classify this compound as practically non-toxic. Competitor is a Class IV cotton seed oil diluent and surfactant (relatively non-toxic). No risk assessments are available for Competitor and little data is available on the toxicity of this compound. LD_{50} values were greater than 5,000mg/kg (Wilbur-Ellis Co. 2005; Bakke 2007, 2003).

Colorants

Spray pattern indicators are dyes or colorants that identify where herbicide has been applied. There are several formulations available for use. Choices depend on many factors including spray formulation, treatment site, and target vegetation.

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