Agronomy Technical Note XXX: Pesticide Mitigation Practices and Techniques

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Introduction

This document is intended to be used as a supporting document to implement the NRCS Conservation Practice Standard (596) Pesticide Risk Mitigation and in general Integrated Pest Management (IPM) planning where there is a need to mitigate for potential losses of pesticides that can may pose offsite risks.

NOTE: If the identified hazards and risks associated with the planned pesticides can be addressed through planned conservation practices or system of conservation practices then those pesticides do not apply to the Conservation Practice Standard – Pesticide Risk Mitigation (596). Also, it is not necessary to assess risk or hazard of pesticides that are used for seed treatment and/or banded with seed, or similar pesticides, where the exposure of these pesticides are very limited.

NRCS Pesticide Risk/Hazard Analysis

Pesticide registrations and label use restrictions are both based on risk analysis and determining if the benefits of a proposed pesticide use outweigh the potential risks. A *risk assessment* is a detailed risk analysis that includes essentially all potential risks to all species that may be impacted by a particular pesticide use. NRCS pesticide risk analysis is a subset of a full risk assessment. NRCS focuses on pesticide environmental risk screening tools and the data used to identify sensitive pesticide/soil combinations that need mitigation to help protect the natural resource base.

The major components of the NRCS Non-Point Source Exposure pesticide risk/hazard analysis are:

1. Field pesticide leachate in water.
2. Field pesticide runoff in water.
3. Field pesticide runoff in sediment.
4. Field pesticide volatization/drift in air.
5. Determining the toxicological hazard posed by the pesticide.
6. Characterizing risk by combining pesticide exposure and toxicity.

Pesticide hazard ratings refer to the WIN-PST soil and pesticide interaction ratings for:

1. IARP (fish) – Soil Pesticide Interactive Adsorbed Runoff Potential for Fish
2. ILP (fish) - Soil Pesticide Interactive Leaching Potential for Fish
3. ISRP (fish) - Soil Pesticide Interactive Solution Runoff for Fish
4. ILP (human) - Soil Pesticide Interactive Leaching Potential for Humans
5. ISRP (human) - Soil Pesticide Interactive Solution Runoff for Humans

WIN-PST is the NRCS technical tool that to assess pesticide hazard based on:

- Pesticide data
- Soils data
- Toxicity data

When using the WIN-PST tool the users enters the client's planned pesticides and the soils on which those pesticides will be applied. Identifying the pesticides is very straight forward. However, most fields contain more than one soil type. So which soil type should be used for the WIN-PST assessment.

Rationale to select the appropriate soil for the soil/pesticide interaction hazard rating.

To determine the appropriate soil/pesticide combination to use for the assessment and mitigation planning do the following:

1. Enter all the soil types into WIN-PST that make up roughly more than 10% of the field.
2. Enter all the client's planned pesticides into WIN-PST.
3. Review and analyze the hazards associated with each soil/pesticide interaction. Select as your planning soil/pesticide combination the combination that makes up approximately 25% of the field (or planning area) that has the highest hazard rating appropriate for the site. For example: Soil A occupies approximately 50% of the field and has a "High" hazard rating for IARP (fish) – Soil Pesticide Interactive Adsorbed Runoff Potential for Fish. Soil B occupies approximately 30% of the field and has a "High" hazard rating for ILP (human) - Soil Pesticide Interactive Leaching Potential for Humans. On this particular field there is no nearby stream – thus the hazard rating for Soil A does not apply to this site. However, there is a treat to underground drinking water in the area from pesticides. In this case Soil B that occupies 30% of the field would be the appropriate Soil for this particular pesticide.

The planner will need to make a decision as to which soil/pesticide combination to base mitigation planning and is dependent upon (1) the soil/pesticide hazard rating, (2) the local field setting, and (3) the amount of area occupied by the soil in question.

When a hazard has been identified by NRCS' current WIN-PST (Windows-bases Pesticide Screening Tool) and the site setting the planner has several choices of how to address that hazard.

The following planning process will guide the planner and the client in the selection of the appropriate mitigation practice(s) (Table II) or IPM Techniques (Table I) to address the site specific risks or hazards.

One way to mitigate the loss pathways is through the application of conservation practices. Table II list several practices and there estimated effect on the loss pathway. This should be the first approach. The minimum index score for mitigation for the given hazard rating is indicated in the chart below.

WIN-PST Identified Hazard Rating	Minimum Mitigation Score Level Needed
Very Low or Low	None Needed
Intermediate	3
High	6
Very High	9

If the application of conservation practices will not minimally address the hazard then the application of one or more IPM Mitigation Techniques outlined in Table 1 should be used. Many of the techniques in Table I below are parts of Land-Grant University Integrated Pest Management (IPM) Programs and form the basis of many producer IPM plans.

NOTE: The scores from Table II can be added with any scores from Table I to calculate the minimum score needed for mitigation.

Generally, the higher the identified hazard the greater the number of techniques that will have to be implemented to mitigate for that risk. Ultimately, the planner with the aid of pesticide professionals, if necessary, will need to determine how much mitigation will be necessary. As a general guide to the planner, the following minimum level of mitigation shall be implemented:

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WIN-PST Identified Hazard Rating	Minimum Mitigation Score Level Needed
Very Low or Low	None Needed
Intermediate	3
High	6
Very High	9

For example, if an Intermediate hazard for adsorbed runoff is identified, then practices from Table II or IPM techniques from Table I that address adsorbed runoff would be implemented so that the sum of the index values in the “Adsorbed Runoff” column for the selected practice(s) or IPM techniques will be 3 or more. Similarly, if a High hazard for adsorbed runoff is identified, then practices from Table II or IPM techniques from Table I that address adsorbed runoff would be implemented so that there the sum of the index values in the “Adsorbed Runoff” column for the selected practices or IPM techniques will be 6 or more. Finally, if a Very High hazard for adsorbed runoff is identified, then practices from Table II or IPM techniques from Table I that address adsorbed runoff would be implemented so that there the sum of the index values in the “Adsorbed Runoff” column for the selected practices or IPM techniques will be 9 or more. This will be the case for all hazards identified by WIN-PST.

Other Considerations to Mitigate Pesticide Hazards and Risks

Risk Reduction by Using a Low Risk Pesticide

The client and/or a certified professional (e.g. Certified Crop Advisor, extension agent, etc.) can identify a lower risk/hazard pesticide that can be used in place of a higher risk pesticide. The reduced risk associated with each pesticide application shall be clearly summarized and documented to show that no new risk from the newly selected pesticide was introduced.

Risk Reduction by Pesticide Usage Reduction

Another alternative to reduce risk/hazard is to reduce the usage of pesticides. An acceptable level of Pesticide Risk Reduction is considered achieved if active ingredient usage is reduced by 50% or more. The manner in which the reduction is achieved is irrelevant (as long as it is done within label).

Other Pesticide Risks

In addition to the WIN-PST hazard ratings one can also assess the client’s planned pesticides’ risk for volatilization and drift. Appropriate mitigation for drift can be selected form Tables I and II in this document.

Volatilization Risk. Risk of volatilization losses is defined in the Pesticide Risk Mitigation Standard (596) under “Criteria Applicable to Reducing Pesticide Volatilization”. The risk reduction with volatilization losses can be achieved by using a pesticide with a vapor pressure of less than 10^{-6} mm Hg.

Drift Risk. Risk from drift losses is difficult to determine because many factors are involved from the presence of temperature inversions, wind speed, temperature, pesticide chemistry, spray nozzle droplet size, etc. If there is evidence of drift, use Table I and Table II as appropriate to address losses with the best professional judgment. A minimum index score of 3 (sum of Table II plus Table I) is the criteria to address the risk of drift.

The following tables identify management techniques that have the potential to mitigate pesticide impacts on water quality. Not all techniques/practices will be applicable to a given situation. Relative effectiveness ratings by pesticide loss pathway are rated from an index value of “0” to an index value of 9. The tables also identify how the practices and IPM techniques function and the performance level the rating is based upon. Effectiveness of any mitigation technique/practice can be highly variable based on site conditions and how it is designed. The professional judgment of the planner will ultimately determine the effectiveness of a particular practice or IPM technique for the field or planning area.

The following tables are based on available research specific to the conservation practice or IPM technique, related research, and the NRCS best professional judgment. The ratings are relative index values as opposed to absolute values, much like the Conservation Practice Physical Effects (CPPE) matrix. They are intended to help planners choose the best combination of conservation practices or IPM techniques for their identified resource concerns. The ratings are based on the relative *potential* for conservation practices or IPM techniques to provide mitigation. The conservation practices or IPM techniques need to be specifically designed, implemented and maintained for the mitigation potential to be realized. Varying site conditions can result in a great deal of variation in actual mitigation effectiveness, but our relative index values indicate which conservation practices or IPM techniques will generally provide more or less mitigation under a given set of conditions. Our general rule of thumb is that an index of 1-3 generally have the potential to reduces losses by 10 -20%., index values of 4-6 have the potential to reduces losses by about 20 - 50% and index values of 7-9 have the potential to reduce losses by about 50 to 95% plus.

The original reference for many of the ratings in Tables 1 & 2 is: *Aquatic Dialogue Group: Pesticide Risk Assessment and Mitigation, Baker JL, Barefoot AC, Beasley LE, Burns LA, Caulkins PP, Clark JE, Feulner RL, Giesy JP, Graney RL, Griggs RH, Jacoby HM, Laskowski DA, Maciorowski AF, Mihaich EM, Nelson Jr HP, Parrish PR, Siefert RE, Solomon KR, van der Schalie WH, editors. 1994. Society of Environmental Toxicology and Chemistry, Pensacola, FL., pages 99-111 and Table 4-2*. This reference provides ranges of effectiveness for various mitigation techniques.

If you have any questions about the material in this publication, please contact the National Pest Management Specialist or your respective State or Regional Agronomist.

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TABLE I – IPM Mitigation Techniques Effectiveness Guide - Reducing Pesticide Losses from the Application Site.

IPM Mitigation Techniques[1, 2]	Pesticide Loss Pathways				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Application Timing – Rain	4	4	4	0	Reduces exposure potential - delaying application when significant rainfall events that would produce substantial runoff or leaching are forecast can reduce pesticide transport to ground and surface water.
Application Timing – Wind	0	0	0	3	Reduces exposure potential - delaying application when wind speed is not in accordance with label requirements can reduce pesticide drift to surface water. Do not apply at wind speeds over 9 mph, ideally over 5mph.
Application Timing – Ambient Temperature	0	0	0	1	Spraying during cooler temperatures (e.g. in the early morning, evening or at night) to reduce drift and volatilization losses. Avoid spraying in temperatures above 90º F.
Application Timing – Relative Humidity	0	0	0	1	Spraying when there is relatively higher humidity reduces evaporation of water from spray droplets thus reducing drift losses.
Formulations/Adjuvants[3]	3	3	3	2	Reduces exposure potential – formulations and/or adjuvants that increase efficacy allow lower application rates **or** formulation that have lower volatilization potential decrease atmospheric losses **or** use adjuvants that reduce drift (drift retardant) when less than ideal conditions are encountered.
Use of alternative, low-hazard pesticides	8[4]	8[4]	8[4]	0	Reduces hazard potential - use alternative pesticides with low environmental hazard (i.e. toxicity).
Use of alternative cultural or biological suppressions	9	9	9	9	Reduces hazard potential - substituting cultural (including burning and mechanical controls) and biological controls can replace the need for pesticide application(s).
Spray Nozzle Selection, Maintenance and Operation	0	0	0	5	Select the appropriate nozzle for the application. Adjust flow rates and pressures to the mid-range for the nozzles. Maintain proper nozzle spacing, boom height and boom suspension. Maintain calibration and check nozzles frequently, replacing worn nozzles when they are identified. Replace cracked or leaking tubing as small, high pressure leaks can produce fine droplets that carry large distances. **States may want to modify for specific nozzle type, pressures, and droplet size.**
Use of low pressure, high volume Spray Nozzles that produce large droplets and narrow droplet size distribution	0	0	0	5	Selecting low pressure, high volume spray nozzles that produce large droplets reduces the chance of drift loss and may have some effect on volatilization losses during the application. **States may want to modify for specific nozzle type, pressures, and droplet size.**
Pesticide Chemistry	0	0	0	0	Selecting a less volatile active ingredient (e.g. 2, 4-D amine instead of 2, 4-D ester) to reduce volatilization losses from the field and reduce offsite

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IPM Mitigation Techniques[1, 2]	Pesticide Loss Pathways				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
					exposure potential. Note, pesticide chemistry will determine K_{OC}, Solubility and Half-life which directly affect leachability and adsorption coefficients, ultimately affecting the loss pathway.
Partial Treatment	8	8	8	0	Reduces exposure potential - spot treatment, banding and directed spraying reduce amount of pesticide applied, assumes no more than 50% of the area treated.
Application only where Scouting and IPM Thresholds indicate a need	5	5	5	0	Reduces exposure potential - reduces the amount of pesticide applied to areas that meet or exceed a previously determined economic threshold value for a particular pest.
Set-backs	0	3	3	2	Reduces exposure potential - reduced application area reduces amount of pesticide applied, can also reduce inadvertent pesticide application and drift to surface water.
Soil Incorporation – mechanical or irrigation	0	7	6	0	Reduces exposure potential for surface losses, but potentially increases exposure potential for leaching losses if K_{OC} is low and Solubility is high.
Use of Semiochemicals to manage pest population	9[5]	9[5]	9[5]	9[5]	Use of semiochemicals (e.g. mating disrupting pheromones) to decrease reproductive success or control population density/location with the goal of reducing or eliminating the need for chemical suppression.
Precision Application – Green sensors	6	6	6	6	Using green sensors substantially reduces the amount of active ingredient applied. This applies to pesticide treatments to suppress green vegetation only.

[1] Additional information on pest management mitigation techniques can be obtained from Extension pest management publications, pest management consultants and pesticide labels.

[2] The pesticide label is the law - all pesticide label specifications must be carefully followed, including required mitigation. Additional mitigation may be needed to meet NRCS identified resource concerns.

[3] Note that in some cases, the “inert ingredient(s)” may pose a greater risk to worker safety and air quality than the active ingredient(s). Selecting formulations other than emulisfiable concentrates (EC) can effectively reduce volatilization losses of the “inert ingredients” but the efficacy of the alternative formulation on the target pest must be considered. In areas that are in “non attainment” with respect to EPA air quality standards, substitution of less volatile pesticide and formulations may be required by the local and/or state authorities.

[4] The actual loss potential may or may not change but, because the alternative pesticide will be much less toxic (i.e. have a much higher LD_{50}) the potential loss of the alternative pesticide will not have nearly the same impact as the previous pesticide. For example substitution of glyphosate for paraquat reduces ISRP RISK from *Intermediate* to *Low* despite glyphosate having a PSRP rating of *High* versus a *Low* PSRP rating for paraquat.

[5] Similar to note 4 above, the actual loss potential may or may not change but, if the activity eliminates the need for chemical suppression the effect is equivalent to the 9 effect. Reference material: Hollis M. Flint and Charles C. Doane. Date (February, 1996). Understanding Semiochemicals with Emphasis on Insect Sex Pheromones in Integrated Pest Management Programs. In: E. B. Radcliffe,W. D. Hutchison & R. E. Cancelado [eds.], Radcliffe's IPM World Textbook, URL: http://ipmworld.umn.edu, University of Minnesota, St. Paul, MN.

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TABLE II – IPM Mitigation Practices Effectiveness Guide - Reducing Pesticide Losses from the Application Site.

Pest Management Mitigation Techniques[1, 2]	Pesticide Loss Pathways				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Alley Cropping (311)	2	3	6	6	Increases infiltration and uptake of subsurface water, reduces soil erosion, can provide habitat for beneficial insects which can reduce the need for pesticides, also can reduce pesticide drift to surface water.
Anionic Polyacrylamide (PAM) Erosion Control (450)	0	3	7	0	Increases infiltration and deep percolation, reduces soil erosion.
Conservation Cover (327)	9	9	9	0	Retiring land from annual crop production into perennial vegetation reduces the need for pesticides, builds soil organic matter, and reduces runoff.
Constructed Wetland (656) or other Natural Wetlands	0	3	6	0	Captures pesticide residues and facilitates their degradation. This would apply to where at 50% of the treatment area drains into the wetland.
Conservation Crop Rotation (328)	4	4	4	0	Reduces the need for pesticides by breaking pest lifecycles. The rotation shall consist at least 2 crops in the rotation and no crop grown more than once before growing a different crop.
Contour Buffer Strips (332)	0	5	5	0	Increases infiltration, reduces soil erosion.
Contour Farming (330)	0	3	3	0	Increases infiltration and deep percolation, reduces soil erosion.
Contour Orchard and Other Fruit Area (Ac.) (331)	0	4	4	0	Increases infiltration and deep percolation, reduces soil erosion.
Contour Stripcropping (585)	0	9	9	0	Increases infiltration, reduces soil erosion and generally will only be treating half the area of concern.
Cover Crop (340) Fully incorporated by plowing or similar tool	2	2	2	0	Increases infiltration, reduces soil erosion, builds soil organic matter. Assumes at least 4000 lbs/ac of live biomass at the time of tillage.
Cover Crop (340) Mulch tilled into soil	2	3	3	0	Increases infiltration, reduces soil erosion, builds soil organic matter. Assumes at least 4000 lbs/ac of live biomass at the time of tillage and at least 30% ground cover at the time of the pesticide application.
Cover Crop (340) that is no-tilled into	2	4	4	0	Increases infiltration, reduces soil erosion, builds soil organic matter. Assumes at least 4000 lbs/ac of live biomass at the time of tillage and at least 60% ground cover at the time of the pesticide application.

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Pest Management Mitigation Techniques[1, 2]	Pesticide Loss Pathways				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Cross Wind Ridges (589A)	0	1	2[3/]	0	Reduces wind erosion and adsorbed pesticide deposition in surface water. Assumes the pesticide was applied while the field in the ridged state.
Cross Wind Stripcropping (589B)	0	5	7[3/]	5	Reduces wind erosion and adsorbed pesticide deposition in surface water, traps adsorbed pesticides. Different pesticides may be applied on one half of the field.
Cross Wind Trap Strips (589C)	0	2	4[3/]	1	Reduces wind erosion and adsorbed pesticide deposition in surface water, traps adsorbed pesticides.
Deep Tillage (324)	0	2	2	0	Increases infiltration and deep percolation.
Field Border (386)	0	2	3	3	Increases infiltration and traps adsorbed pesticides, often reduces application area resulting in less pesticide applied, can provide habitat for beneficial insects which reduces the need for pesticides, can provide habitat to congregate pests which can result in reduced pesticide application, also can reduce inadvertent pesticide application and drift to surface water. Assumes 20 feet wide.
Filter Strip (393)	0	4	5	0	Increases infiltration and traps adsorbed pesticides, often reduces application area resulting in less pesticide applied, can provide habitat for beneficial insects which reduces the need for pesticides, can provide habitat to congregate pests which can result in reduced pesticide application, also can reduce inadvertent pesticide application and drift to surface water. Assume 30 feet wide.
Forage Harvest Management (511)	5	5	5	0	Reduces exposure potential - timely harvesting reduces the need for pesticides.
Herbaceous Wind Barriers (603)	0	2	3[3/]	3	Reduces wind erosion, traps adsorbed pesticides, can provide habitat for beneficial insects which reduces the need for pesticides, can provide habitat to congregate pests which can result in reduced pesticide application, also can reduce pesticide drift to surface water.
Irrigation System, Microirrigation (441)	5	6	6	0	Reduces exposure potential - efficient and uniform irrigation reduces pesticide transport to ground and surface water.
Irrigation System, Sprinkler (442)	3	4	4	0	Reduces exposure potential - efficient and uniform irrigation reduces pesticide transport to ground and surface water.
Irrigation System, Subsurface (443)	1	5	5	0	Reduces exposure potential - efficient and uniform irrigation reduces pesticide transport to ground and surface water.

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Pest Management Mitigation Techniques[1, 2]	Pesticide Loss Pathways				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Irrigation System Tail Water Recovery (447)	0	6	6	0	Captures pesticide residues and facilitates their degradation.
Irrigation Water Management (449)	5	5	5	0	Reduces exposure potential - water is applied at rates that minimize pesticide transport to ground and surface water, promotes healthy plants which can better tolerate pests.
Mulching (484)	2	4	4	0	Often reduces the need for pesticides, natural mulches increase infiltration and reduce soil erosion.
Residue Management, No-till and Strip-Till (329A)	1	4	6	0	Increases infiltration, reduces soil erosion, builds soil organic matter. Assumes at least 60% ground cover at the time of application.
Residue Management, Mulch-Till (329B)	1	3	4	0	Increases infiltration, reduces soil erosion, builds soil organic matter. Assumes at least 30% ground cover at the time of application.
Residue Management, Ridge Till (329C)	1	3	5	0	Increases infiltration, reduces soil erosion, builds soil organic matter.
Riparian Forest Buffer (391)	1	5	6	0	Increases infiltration and uptake of subsurface water, traps sediment, builds soil organic matter. Assumes 30 feet wide minimum.
Riparian Herbaceous Cover (390)	1	4	5	0	Increases infiltration, traps sediment, builds soil organic matter. Assumes 30 feet wide minimum.
Sediment Basin (350)	0	0	4	0	Captures pesticide residues and facilitates their degradation. This would apply to where at 50% of the treatment area drains into the sediment basin.
Stripcropping, Field (586)	0	6	6	0	Increases infiltration, reduces soil erosion.
Subsurface Drainage (606)	0	2	2	0	Increases infiltration and aerobic pesticide degradation in the root zone *Note – avoid direct outlets to surface water
Terrace (600)	0	3	5	0	Increases infiltration and deep percolation, reduces soil erosion.
Vegetative Barriers (601)	0	0	2	0	Reduces soil erosion, traps sediment, increases infiltration.
Windbreak/Shelterbelt Establishment (380)	0	0	0	5	Reduces wind erosion, reduces adsorbed pesticide deposition in surface water, traps adsorbed pesticides, also can reduce pesticide drift.

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[1/] Additional information on pest management mitigation techniques can be obtained from Extension pest management publications, pest management consultants and pesticide labels.
[2/] The pesticide label is the law - all pesticide label specifications must be carefully followed, including required mitigation. Additional mitigation may be needed to meet NRCS pest management requirements for identified resource concerns.
[3/] Mitigation applies to adsorbed pesticide losses being carried to surface water by wind.

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