United States Department of Agriculture
NATURAL RESOURCES CONSERVATION SERVICE
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Water Quality Indicator Tools

(Adapted for Montana from Water Quality Technical Note No. 1, Portland, Oregon, October 2000)

Purpose and Scope

This technical note provides information on *water quality indicator tools* for use by Natural Resources Conservation Service (NRCS) personnel and others. These tools are organized and designed to be used in conjunction with the Field Office Technical Guide (FOTG), Section III, Quality Criteria. These tools are to be used to indicate and document whether Conservation Management Systems (CMS) meet the water quality criteria at the Resource Management System (RMS) level (National Planning Procedures Handbook (NPPH), Amendment 2, April 1998). A CMS combines individual conservation practices into a system that, when installed, prevents degradation and permits sustained use of our natural resources (soil, water, air, plants and animals).

Indicators provide a measure for, or can describe a current, past, or future resource condition. Indicators only estimate resource conditions so their use must be combined with common sense and professional judgment. The tools presented also provide general background into the pollution process for different water quality parameters. This information can help educate and remind conservation planners of resource considerations related to water quality. Indicator tools can be used to determine water quality problems, set benchmark conditions, guide inventories, and evaluate and document water quality in the future. The planner can use the tools with their clients to help them understand pollution concepts and how different conservation practices can reduce or eliminate risks of pollution. Our clients could use most of the tools to do their own self-assessments.

Policies and Regulations

Clean water is essential to sustain life. Given its importance, the huge amount of regulations and policies currently in place is not surprising. Federal legislation addressing water quality dates back to the Rivers and Harbors Act of 1899 which prohibited disposal of waste materials on the banks of waterways. The Federal Water Pollution Control Act amendments of 1972, known as the Clean Water Act (CWA), set an interim goal popularly referred to as “fishable/swimmable” waters. The specific CWA objective is to restore and maintain the chemical, physical and biological integrity of the Nation’s waters. Most current water quality policies and regulations emanate from the CWA. Appendix A contains a table summarizing most of the pertinent agency policy, and federal and state regulations.

Montana has long recognized the importance of clean water and of protecting critical water resources while accommodating human uses of those water resources. The Montana Constitution recognizes this charge, “[a]ll persons….have certain inalienable rights….includ[ing] the right to a clean and healthful environment and the rights of pursuing life’s basic necessities….In enjoying these rights, all persons recognize corresponding responsibilities (Article II, Section 3). The first water quality law in Montana was passed in 1907 to require the treatment of all sewage discharged into public waters in response to an outbreak of typhoid in the Milk River watershed. Since then, a number of state statues have collectively come to be referred to as the Montana Water Quality Act (MCA 75-5-101). The Act incorporates elements of the Federal Clean Water Act as well as Montana specific policies to prevent, abate, and control the pollution of Montana’s water consistent with national standards.

The Montana Department of Environmental Quality (DEQ) administers the Water Quality Act. DEQ has been designated a discharge permit issuing authority by the Environmental Protection Agency (EPA) for point sources that discharge to state waters. In Montana, water quality standards extend to all state waters which include ground and surface water. The term, state water, does not apply to: 1) ponds or lagoons used solely for treating, transporting, or impounding pollutants; or 2) irrigation waters or land application disposal waters when the waters are used up within the irrigation or land application disposal system and the waters are not returned to state waters."[1/] State waters do not include waters originating on or flowing through designated tribal lands in Montana except where a shared boundary exists. On tribal lands, the Federal Water Quality Act is administered by the EPA unless superseded by approved tribal regulations.

According to the DEQ, water quality standards extend to all of the State's surface waters (rivers, streams, lakes, reservoirs, wetlands, etc., excepting Tribal Lands where the Clean Water Act then applies). The state's water quality standards classification system is based on large geographic basins, not on individual water bodies. State water quality standards make a distinction between ephemeral and intermittent water bodies. Intermittent and perennial water bodies are protected by both narrative and numeric criteria, whereas ephemeral water bodies are only protected by narrative standards. Definitions of ephemeral and intermittent water bodies (as well as classifications, and narrative standards) can be found in the Administrative Rules of Montana (ARM) 17.30.601 through 17.30.670.[2/]

Tribal authorities are in the process of establishing (through application to EPA) their own water quality standards. At this point in time, no tribal water quality standards have been formally approved by EPA, although the Northern Cheyenne Tribe has been granted Treatment as a State (TAS), the first step in the process of developing and submitting water quality standards to support tribally recognized beneficial uses.

Ground water is also protected with State water quality standards and classifications, although these rules are more general (fewer classes and fewer beneficial uses). These are found at ARM 17.30.621 through 629.

Montana identifies seven designated uses of water: Agricultural, Aquatic Life, Cold Water Fishery, Warm Water Fishery, Industrial, Drinking Water, and Primary Contact Recreation. Numeric standards have been established for each of these classifications in Circular DEQ-7, Montana Numeric Water Quality Standards.[3/]

The Montana Water Quality Act prohibits discharge of pollutants or placement of wastes that cause pollution without authorization (a discharge permit), including pollution from non-point sources. Agricultural non-point sources are generally exempted from the act as long as they are utilizing "all reasonable land, soil, and water conservation practices.

NRCS policy (GM 460-401) relative to water quality is, "to promote the improvement, protection, restoration, and maintenance of surface and ground water quality for beneficial uses." Clean and Abundant Water is one of the six mission goals identified in the agency's 2005-2010 Strategic Plan.

The outcome of this goal is stated as, "The quality of surface and ground water is improved and maintained to protect human health, support a healthy environment, and encourage a productive landscape. To accomplish this outcome, NRCS will:

[1/] MCA § 75-5-103(29).
[2/] Available at: http://www.deq.state.mt.us/wqinfo/Standards/Index.asp
[3/] http://www.deq.state.mt.us/wqinfo/Standards/Index.asp

- Provide assistance toward the prevention and correction of water quality problems;
- Ensure activities are in accordance with State defined water quality standards, uses, and priorities;
- Coordinate activities with local, state, federal agencies and others to protect water quality and to promote technology development and transfer;
- Create public understanding of water quality concerns;
- Support data gathering, technology development, and research needed to assess water quality resource concerns and the effectiveness of best management practices; and
- Train agency personnel in water quality concepts.

FOTG, Section III, Quality Criteria for all water quality resource concerns can be summarized into "meeting state water quality standards."

Principles of Water Quality

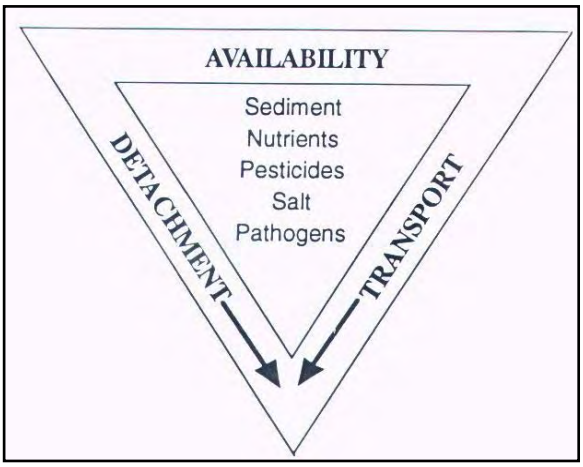
Water quality is defined by its capability to support the beneficial uses of a water body. A water quality problem exists when the beneficial or intended use of that water body is impaired. Chemical, physical, and biological parameters are used to measure water quality. Common parameters include bacteria, dissolved oxygen, nutrients, pH, sedimentation, turbidity, temperature, electrical conductivity, and toxics (heavy metals and volatile organics). Water quality can also be measured in terms of riparian/aquatic habitat condition or from biotic indices of macro-invertebrate, fish, or algal populations. Water quantity plays an important role in quality by influencing a water body's assimilative capacity and ability to support aquatic life.

To solve a water quality problem resulting from agricultural activities:

Identify the pollutant or stressor causing the problem;

(a) Determine the cause and effect relationship between the pollutant or stressor and the water quality impairment;
(b) Describe the source and pathway of the pollutant; and
(c) Select and apply appropriate control practices.

A stressor is any condition caused by management activities. For example, a reduction of streamside shading can cause elevated water temperatures that adversely impact aquatic habitat communities.



The pollution process can be visualized through the pollutant delivery triangle:

- Availability - presence and amount of contaminant available.
- Detachment - process by which material is mobilized
- Transport - pathway by which a pollutant leaves agricultural area to receiving waters.

Control of most pollutants can be assessed in terms of the capability to impact one or more of these three processes. For example, integrated pest management limits the amount of chemical pesticide used or reduces its *availability*. Erosion control practices control *detachment* of soil particles and subsequent sedimentation. A filter strip or buffer intercepts the *transport* of sediments to a water body.

Some water quality concerns like stream temperature, riparian habitat, and stream flow cause direct impacts to the stream. Understanding of basic riparian habitat management, hydrology, and geomorphological principles is necessary to determine appropriate solutions to these non-chemical water quality problems. Water quality guidelines for most agricultural uses of water are provided in Environmental Technical Note 1.

FOTG Quality Criteria

Quality criteria are quantitative or qualitative statements of a treatment level required to achieve an RMS for identified resource considerations for a particular land area. They are established in accordance with local, state, and federal programs and regulations in consideration of ecological, social, and economic effects. NRCS planning procedures suggest quality criteria be expressed using a *target* and an *indicator*. The term target value is used to express a desired future condition of a resource as measured by an *indicator*. Another way of looking at indicators and target values is to think of a yardstick as the indicator and the target as a point on that yardstick.

The following sections describe the FOTG, Section III, water quality resource concerns along with tools that can be used to evaluate quality criteria. Included are descriptions for pesticides, nutrients and animal wastes, salinity, heavy metals, suspended sediment and turbidity, dissolved oxygen, aquatic habitat suitability and temperature, and petroleum products. NRCS and others have previously developed many of the referenced tools. Worksheet versions of new tools created for this technical note are included in Appendix B.

These tools only provide estimates of resource conditions. They should always be used with common sense and professional judgment to deduce the status of water quality resource concerns. A deductive approach, aided by predictive tools, can be used to determine the appropriate treatment level for a particular water quality concern. Predictive tools alone cannot capture the variance in water quality concerns impacted by non-point sources. Cumulative impacts and individual characteristics of each water body and watershed limit the precision of predictive tools.

In areas with sensitive water bodies and/or vulnerable aquifers, the planner should exercise additional care in the tool's application and interpretation to minimize risk to the environment and human health. Sensitive waters could include those listed as water quality limited (303d list or 305b report), harboring endangered or threatened species, sole source aquifers, public water supply recharge areas, or others suffering from effects caused by human impacts.

Suggested target levels to meet quality criteria are listed for indicator tools referenced in this technical note. ***Appendix B contains input sheets for computerized tools or hard copies of worksheet tools.*** The planner must still deduce if the suggested targets provide the appropriate level of water quality protection for site conditions being analyzed.

Pesticides

Pesticides-insecticides, herbicides, fungicides, miticides, nematicides, etc., are used extensively to control plant and animal pests and enhance production. Storage, mixing, rinsing, and land application activities can potentially increase the risk of environmental pollution. Exposure to pesticides poses potential health risks to humans and the environment. Pesticides may harm the environment by eliminating or reducing desirable organisms and upsetting complicated eco-system relationships. Toxic effects of pesticides are referred to as acute (immediate lethal or sub-lethal effects) or chronic (cumulative effects from long-term exposure).

Many physical, chemical and biological parameters affect a pesticide's potential environmental hazard. Three pesticide properties are often used to describe their potential to contaminate water:

- Solubility
- Half-life
- Adsorption.

Solubility is the measure of a pesticide's ability to dissolve in water. Pesticides with higher solubility have a greater potential to be lost in runoff or in migration to ground water.

The persistence of a pesticide is measured as the time for one-half of the applied material to disappear (half-life). In some cases, a pesticide may degrade into a different compound or metabolite with more persistence and/or toxicity than the original pesticide.

A pesticide's chemical properties along with soil characteristics (moisture, pH, organic matter, clay content, and texture) determine the extent to which a pesticide is sorbed to soil particles. The sorption coefficient (K_{oc}) measures the quantity of pesticide adsorbed by the soil. For example, dicamba salt has a low sorption coefficient (K_{oc} of 2) and benomyl has a high coefficient (K_{oc} of 1900). Consequently, dicamba salt is highly mobile compared to benomyl which will be tightly bound to soil particles.

Availability of pesticides is best controlled through proper pest management that minimizes the use of specific pesticides through integrated pest management techniques. Integrated Pest Management (IPM) combines biological, cultural and other alternatives to chemical control with the judicious use of pesticides. IPM includes activities like:

- Scouting
- Forecasting pest outbreaks
- Introducing beneficial insects
- Using pest resistant crops, crop rotations, cultivation, and fertility management
- Altering pesticide selection and application (timing, rate and form).

New developments in precision agriculture combining remote sensing and global positioning system technology now make it possible to apply pesticides to specific plants and at variable rates within a field thereby further limiting the availability of pesticides.

Pesticide *detachment* and *transport* within the environment is governed by several factors:

- Pesticide's properties (solubility, half-life, and adsorption)
- Soil characteristics (runoff, leaching and erosion potential)
- Precipitation, temperature and other climatic conditions.

Evaluating and understanding these properties should help the planner devise pest management alternatives that will minimize potential negative impacts. Rate, form, method, and timing of a pesticide application all become important components. Supporting conservation practices that reduce erosion, runoff, and leaching reduce detachment of pesticides while practices such as filter strips, buffers, sediment ponds, and grassed waterways can be used to interrupt the transport of pesticides.

Several tools exist that can be used to indicate whether pesticide use meets FOTG, Quality Criteria for field application to crops and pastureland, and for pesticide storage, handling, and disposal. The following table lists the tools, applicability to surface and ground water concerns, RMS target level, and

reference. The RMS target level simply indicates a low-risk situation for a pesticide's use. A moderate or high risk rating does not necessarily mean a pesticide cannot be used, nor does a low or very low rating mean indiscriminate application is appropriate. Observation of setting, climate, operator's skill and other factors combined with the planner's own professional judgement must be used to deduce if a particular pesticide represents a water quality hazard and what mitigating practices might be needed. *Note that the planned conservation management system must include practices that overcome the specific site or chemical limitations and/or utilize integrated pest management to limit pesticide use.*

Pesticide Indicator Tools	Surface/ Ground Water	RMS Target Level	Information Contact
Field Application:			
Windows Pesticide (WIN-PST) Screening Tool (Computer Model Tool)	Both	Low or Very Low	Appendix B, WIN-PST Input sheet. Download current WIN-PST tool from http://www.wcc.nrcs.usda.gov/pestmgt
Farm*A*Syst Pesticide Storage, Handling, and Disposal Worksheet	Ground	Low to Low-Moderate Risk	Appendix B, Farm-A-Syst Worksheet #2, Pesticide Storage, Handling and Disposal Worksheet. Hard copies available from Clain Jones, Extension Fertility Specialist, Montana State University, Bozeman.
Water Quality Indicators Guide – Field Sheet 4B – Pesticides	Surface	Ratings of Good to Excellent	Appendix B, Pesticide Indicators Field Sheet 4B for Cropland, Hayland or Pasture or request Water Quality Indicators Guide, Terrene Institute, 1717 K Street NW, Suite 801, Washington, D.C. 20006.
Pesticide Storage, Handling, and Disposal:			
Farm*A*Syst Pesticide Storage, Handling, and Disposal Worksheet	Both	Low to Low-Moderate Risk	Appendix B, Farm-A-Syst Worksheet #2, Pesticide Storage, Handling and Disposal Worksheet. Hard copies available from Clain Jones, Extension Fertility Specialist, Montana State University, Bozeman.

Table 1. Pesticide indicator tools, target levels for Resource Management Systems (RMS) and contact information for each tool.

The ***Windows Pesticide Screening Tool (WIN-PST)*** compares soil properties with pesticide properties to determine loss potentials. ***WIN-PST*** follows the soil pesticide interaction screening procedure (SPISP) originally developed by Don Goss, NRCS Soil Scientist in the early 1990's. ***WIN-PST*** adds conservation management practices to SPISP to evaluate how mitigating measures can modify pesticide loss potentials. In addition, the model adds ratings on the pesticide's toxicity to humans and fish. ***WINPST*** can be used to evaluate both benchmark conditions and RMS alternatives. The ***Water Quality Indicators Guide (Field Sheet 4B)*** evaluates a cropland field's potential for surface loss of a generic pesticide.

For example, assume a client in Yellowstone County grows irrigated alfalfa. The client applies Treflan 5G (trifluraline) to control broadleaf weeds in the spring. The major soil in the field is a Glenberg FSL (Gh). The client applies no practices to control erosion or runoff. The farm is adjacent to the Yellowstone River.

The dealer provides recommendations to the client for four pesticides which could be used: Treflan (trifluralin), Sinbar (terbacil), Eptam (EPTC), and 2,4-DB. The planner scans all four pesticides with the ***WIN-PST*** tool to determine if some pesticides represent less environmental risks than others. The results are shown in the following table:

WINPST Soil/Pesticide Interaction Ratings for Glenberg FSL Soil, Yellowstone County, Montana				
Pesticide Trade name (common name)	**Runoff Loss Potentials**	**Soil/Pesticide Interaction Rating**	**Hazard Human Hazard**	**Hazard Fish Hazard**
Sinbar (terbacil)	Leaching Surface Runoff Adsorbed Loss	High High Intermediate	Low Low	Low Low Very Low
Treflan (trifluralin) - incorporated	Leaching Surface Runoff Adsorbed Loss	Intermediate Low Intermediate	High Intermediate	Extra High High Low
Preplant incorporated Eptam (EPTC)	Leaching Surface Runoff Adsorbed Loss	Intermediate Low Low	Very Low Very Low	Very Low Very Low Very Low
2,4-DB – foliar	Leaching Surface Runoff Adsorbed Loss	Low Intermediate Low	Low Low	Low Low Very Low

Table 2. Depicts interactions of soil and pesticide to calculate ratings in WIN-PST model for the Glenberg FSL Soil in Yellowstone County, Montana.

Glenberg FSL soils, as managed, have a high leaching potential, intermediate surface loss potential and intermediate adsorbed loss potential. The soil/pesticide interaction ratings ***(WIN-PST)*** for Treflan, the producer-selected pesticide, are intermediate for leaching, low for surface loss, and intermediate for adsorbed loss (attached to eroded soils particles). The human and fish toxicity hazards are high to extra high for leaching and intermediate to high for surface runoff.

Hazard ratings of "Low" or "Very Low" require no further action if the pesticides are used according to the label and meet quality criteria for Resource Management Systems. IPM methodologies, where available, shall be incorporated into planning alternatives, even when soil-pesticide interaction hazard ratings are "Low" or "Very Low". Hazard ratings of "Intermediate" or "High" require conservation treatment techniques to meet quality criteria for an RMS. "High" ratings warrant more extensive treatment than "Intermediate" ratings. Conservation treatment techniques may not be effective for "Extra High" hazard ratings. In these cases, an effective, economically acceptable pesticide with a lower environmental risk or an alternate method of pest control shall be considered. In the case of "Extra High" leaching hazard for fish and humans and located in a sensitive area (such as adjacent to the Yellowstone River), conservation treatment techniques are considered to not be effective and the planner shall suggest selection of another alternative.

With Treflan, the target RMS levels are exceeded for leaching (ground water) and surface runoff hazards. Treatment alternatives that add erosion/runoff control such as a setback and riparian herbaceous cover would reduce the high and intermediate soil/pesticide interaction ratings. However, the Extra High rating for leaching will be difficult to reduce to the RMS level with just irrigation water management. The planner would want to suggest that another effective, economically acceptable pesticide with a lower environmental risk be selected or that another alternative using various combinations of cultural and mechanical weed control be selected. The planner must evaluate each alternative to ensure that each is sufficient to meet quality criteria. Other factors such as the distance to a receiving water body like ground water or the Yellowstone River and the probability of runoff from a rainfall event should also be considered when deciding whether quality criteria will be met.

The ***Pesticide Storage, Handling, and Disposal Worksheet*** provides an assessment tool that can be used to judge the pesticide risks associated with their storage, handling and disposal. The worksheet provides a basis for indicating if quality criteria is being met and helps identify practices that need to be considered. The worksheet was derived from Farm*A*Syst worksheets on pesticide storage and handling.

Assume the same client stores over 55 gallons of mostly liquid pesticides. Most have a high leaching or surface loss potential. They are stored in their original, good condition containers inside a shed with a concrete floor with a curbed foundation. Mixing occurs outside on a pervious soil surface located near (less than 50 feet from) an ephemeral ditch. Pesticide materials are hand poured into a sprayer. All handling and cleanup occurs at the same site, rinsate is dumped on the ground. Used containers have been stacked, outside the shed for a number of years.

Based on this information and using the ***Pesticide Storage, Handling, and Disposal Worksheet***, this client has a moderate to high risk of creating a surface or a ground water problem. If the RMS alternative includes: practices for mixing and handling pesticides on an impervious surface with curbs and sump; and recommends use of more dry product formulations, collecting rinsate and applying back on targeted fields, properly recycling used containers, and installing an anti-backflow device, the rating would improve to low-moderate risk meeting the target RMS level.

Other Pest Management References:

Publications

"Agricultural Chemicals Management", NRCS, National Water and Climate Center, October 1996.
"Water Quality Field Guide", USDA/SCS, SCS-TP-160, March 1988.
"Water Quality Indicators Guide", Terrene Institute, Washington, D.C., January 1996.
"Farm*A*Syst", Montana State University, December 1992.

Training Materials

Nutrient and Pest Management Course and Workbook Materials, NRCS National Employee Development Center, 2001. http://www.wcc.nrcs.usda.gov/pestmgt/nedc/NEDCPM.html
NWCC Core 4; Part 3, Pest Management http://www.wcc.nrcs.usda.gov/pestmgt/core4.html

Internet Sites

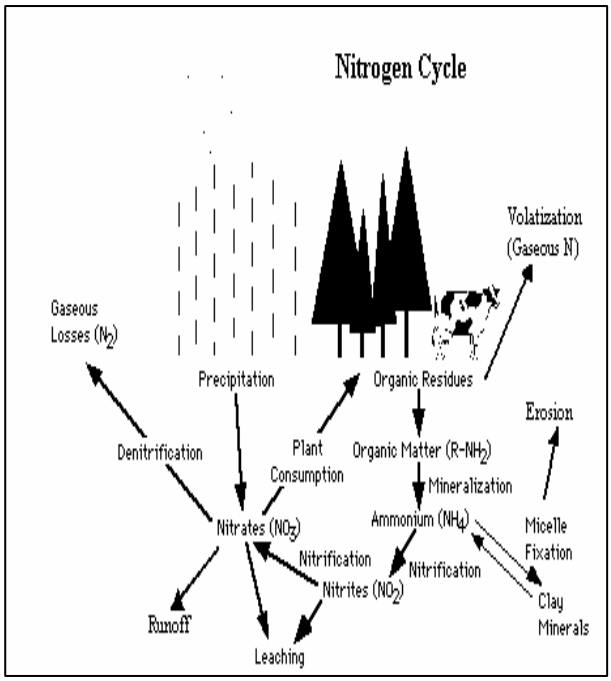
Windows Pesticide Screening Tool, http://www.wcc.nrcs.usda.gov/pestmgt/winpst.html
ARS Pesticide Properties Database, http://www.ars.usda.gov/Services/docs.htm?docid=14199s
University of California, Davis IPM Project,
http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html
Washington State Urban Pesticide Page, http://pep.wsu.edu
The Extension Toxicology Network, http://ace.orst.edu/info/extoxnet/
National IPM Network, http://cipm.ncsu.edu/ent/ncpmip
EPA Office of Pesticides, http://www.epa.gov/pesticides/
NRCS Pest Management Page, http://www.wcc.nrcs.usda.gov/pestmgt

Nutrients, Organics and Pathogens

Nutrients are defined as any organic or inorganic substances that promote plant or animal growth. Organics include animal wastes and other bio-solids. Animal wastes can contribute nutrients, organic matter, and pathogens to receiving waters. Nitrogen and phosphorus are the two major nutrients from agriculture that can degrade water quality. When these nutrients are introduced into a stream, lake or estuary at excessive rates, aquatic plant productivity may be increased dramatically by a process referred to as eutrophication. Eutrophication has many negative side effects on aquatic ecosystems. Increased growth of algae and aquatic weeds can degrade water quality, reduce dissolved oxygen levels, cause wide

pH fluctuations and interfere with use of the water for fisheries, recreation, industry, agriculture, and drinking. Toxins produced by explosive growth of some algae and dinoflagellates can pose serious health threats to humans, wildlife, and livestock. High levels of nitrate (>10 ppm nitrate nitrogen) in drinking water reduces the oxygen carrying capacity of blood which is potentially dangerous to infants (blue baby syndrome). Organic matter includes a family of compounds containing carbon. Excessive concentration of organic matter in surface water results in increased turbidity and oxygen consumption. In ground water, organics can cause undesirable odors and tastes. Pathogens associated with animal wastes can transmit diseases to humans and livestock.

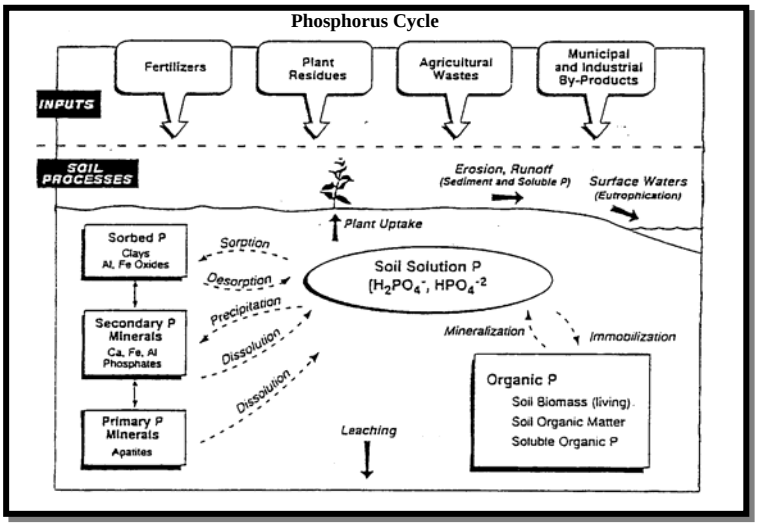
Nitrogen (N) is naturally present in soil but is often added to increase crop production. Only nitrate and ammonium ions are taken up by plants. Because of the complexities of the nitrogen cycle, it's difficult under typical field conditions to account for all sources and sinks of nitrogen.



- -- Mineralization: Conversion of organic N to ammonium NH_4^+
- -- Nitrification: Conversion of ammonium NH_4^+ to nitrate NO_3^- through microbial process
- -- Denitrification: Conversion of nitrate NO_3 to atmospheric nitrogen N_2 or N_2O
- -- Volatilization: Ammonia NH_3 to gas loss
- -- Immobilization: Uptake of nitrogen by soil microbes
- -- Plant Consumption: Uptake NO_3^- and NH_4^+ by plants
- -- Leaching and runoff: Negatively charged nitrate moves readily with water through the soil, below the root zone or running off a field.
- -- Erosion: Positively charged ammonium is held to soil particles and therefore is more apt to be lost by erosion.

Commercial fertilizers applied in the form of nitrate and ammoniums are readily available to plants but also are susceptible to loss through leaching, runoff, and erosion. Adding nitrification inhibitors to ammonium fertilizers slows down the microbial conversion to nitrate-N which helps reduce N loss in surface runoff and leaching. Urea-based fertilizers and animal wastes convert to ammonia, which is subject to volatilization losses unless incorporated into the soil (changed to NH_4^+ and adsorbed to soil particles). A portion of animal wastes contains more stable organic-N that must slowly go through mineralization and nitrification before it's available to plants. Consequently, only a portion of N from animal wastes is converted to plant available forms in the year the manure is applied. Ammonia, if delivered directly to water bodies, can be very toxic to fish and aquatic invertebrates and can deplete the water of dissolved oxygen. Gas losses from denitrification and volatilization contribute to air quality and greenhouse gas concerns.

Phosphorus (P) is one of the key essential elements for plant growth. Fertilization of crops comprises the largest proportion of P used in agriculture. Phosphorus has important functions in plant growth, the primary one being the storage and transfer of energy through the plant. Excess phosphorus in water bodies promotes eutrophication.



Only a small percentage of phosphorus in the environment is readily available for use by living organisms. The orthophosphate ($H_2PO_4^-$, HPO_4^{-2}, and PO_4^{-3}) ion (or dissolved P) is the form that is readily soluble and available for use by biological systems. The majority of inorganic phosphorus in the environment is adsorbed to the iron, aluminum, and manganese oxides or to clay particles. Organic phosphorus is mostly held in soil organic matter. The portion of the phosphorus held by the soil that is subject to change is referred to as the labile fraction. The equilibrium between the labile and dissolved P depends on the biological and chemical characteristics of the soil or water body. Phosphorus is very insoluble in both acidic and alkaline soils, and most soluble in pH neutral soils (6.0 to 7.5). Most P is moved into runoff from agricultural fields by dissolution and erosion. Although generally considered a less important mechanism than surface runoff, P leaching followed by shallow lateral subsurface flow can contribute dissolved P to surface waters, especially where high water tables exist. Soils with large macro pores also facilitate dissolved P loss. This mechanism becomes more important in soils with a large accumulation of P that saturate surface soil sorption capacity leading to downward and lateral movement of P. Phosphorus applications (commercial fertilizers or animal wastes) beyond this threshold increase the opportunity for loss of dissolved P. Animal wastes have proportionally more phosphorus than nitrogen compared to plant requirements, resulting in the buildup of excess phosphorus if wastes are applied at agronomic rates for nitrogen.

Availability of nutrients is best controlled through proper nutrient management that budgets nutrient application according to residual soil nutrient levels and crop requirements. Soil tests, testing nutrient content of manure and basing nutrient requirements on reasonable yield estimates are needed for accurate nutrient budgets. Modern precision agricultural practices that incorporate Geographic Positioning System (GPS) tools provides variable rate application technology create crop management zones that better balance fertilizer application with consumption thereby reducing availability.

Nutrient *detachment* and *transport* within the environment is governed by several factors:

- -- Nutrient form, method of application, and timing.
- -- Soil characteristics (runoff, leaching and erosion potential; clay content, pH, etc.,)
- -- Precipitation, temperature and other climatic conditions.

Nutrient detachment controls are primarily management practices to prevent surface flow or water infiltrating into the soil from coming in contact with nutrients. Timely incorporation of manure, sludge, or fertilizers beneath soil surface can reduce excess nutrients in runoff. If the nutrients cannot be incorporated, they should be spread on fields with close-growing crops or crop residue to control runoff and erosion. Prevention of nutrient contamination of ground water can also be accomplished by use of nutrient forms that are not easily detached such as low solubility or slow release fertilizers. Nutrient applications can be applied in split applications to be available in the amounts and in the time frames crops need them. Supporting practices such as filter strips, buffers, sediment ponds, and grassed waterways can be used to interrupt the transport of nutrients. Cover crops can be used to utilize excess soil nutrients. Deep-rooted crops within a rotation can recycle nutrients that have moved below the rooting zone of more shallow-rooted crops.

Nutrients, Organics, and Pathogens Indicator Tools	Surface or Ground Water	RMS Target Level	Information Contact
Field Application:			
Nutrient Budgets	Both	No Application Exceedance of Nutrient Recommend-ations	Fertilizer Guidelines for Montana Crops, 2003, based on EB 161, Montana State University, Bozeman http://www.mt.nrcs.usda.gov/technical/ecs/agronomy/nutrient/fertilizer.html http://www.montana.edu/wwwpb/pubs/eb161.html Manure Management Planner for animal waste applications: http://www.agry.purdue.edu/mmp
Nitrogen Index	Both	Low or Medium Rating	Appendix B.
Phosphorus Index for Montana	Surface	Low or Medium	See Phosphorus Index Assessment for Montana Agronomy Technical Note Number MT-77 (Revision 3) ftp://ftp-fc.sc.egov.usda.gov/MT/www/technical/agronomy/Agronomy_Tech_Note_MT77Rev3.pdf
Water Quality Indicators Guide - Field Sheet 3B - Nutrients	Surface	Ratings of Good to Excellent	Appendix B, or see Water Quality Indicators Guide, Terrene Institute, 1717 K Street NW, Suite 801, Washington, D.C. 20006
Water Quality Indicators Guide - Field Sheet $2B_1$ - Animal Waste Pasture or Range	Surface	Ratings of Good to Excellent	Appendix B, or see Water Quality Indicators Guide, Terrene Institute, 1717 K Street NW, Suite 801, Washington, D.C. 20006
Water Quality Indicators Guide - Field Sheet $2B_2$ - Animal Waste Totally or Partially Confined	Surface	Ratings of Good to Excellent	Appendix B, or see Water Quality Indicators Guide, Terrene Institute, 1717 K Street NW, Suite 801, Washington, D.C. 20006
Fertilizer Storage and Handling			
Farm*A*Syst Fertilizer Storage and Handling Worksheet	Both	Low to Low-Moderate Risk	Appendix B. Hard copies available from Clain Jones, Extension Fertility Specialist, MSU-Bozeman or NRCS Water Quality Specialist.
Livestock Manure Management			
Farm*A*Syst Livestock Manure Storage Worksheet	Both	Low to Low-Moderate Risk	Appendix B. Hard copies available from Clain Jones, Extension Fertility Specialist, MSU-Bozeman or NRCS Water Quality Specialist.
Farm*A*Syst Livestock Yard Management Worksheet	Both	Low to Low-Moderate Risk	Appendix B. Hard copies available from Clain Jones, Extension Fertility Specialist, MSU-Bozeman or NRCS Water Quality Specialist.
Assessing Ground Water Contamination Risk from AFOs	Ground	N/A See Tech Note	Technical Note MT-ENV-3. Assessing the Risk of Ground Water Contamination from Open Lot Management on Animal Feeding Operations (AFOs) http://www.mt.nrcs.usda.gov/technical/ecs/environment/technotes/envmt3/index.html

Table 3. Quality Criteria Assessment Tools for Nutrient-Related Resource Concerns.

Animal wastes are potential sources of approximately 150 diseases. Numerous factors influence the nature and amount of disease-producing organisms that reach surface or ground water. Some of these are climate, soil type, and depth to water table, infiltration rate, topography, animal type, and presence of disease-causing organisms. When livestock wastes are applied on dry, sunny days harmful bacteria die off quite rapidly. Manure applied on cool rainy days to saturated soils can yield high concentrations of bacteria and viruses in runoff. Pathogens are carried with surface runoff or subsurface flows to receiving waters if not intercepted by adequate vegetative buffers. For quality criteria purposes, it generally can be assumed that if animal manures are properly managed as nutrients, that pathogens will also be controlled.

Several tools exist that can be used as indicators of whether nutrient use meets the nutrient RMS target level. The previous Table 3 lists the tools, applicability to surface and ground water concerns, RMS target level, and reference.

Note: *The planned conservation management system must include practices that overcome the site and management limitations that create the risk of nutrient loss to runoff and leaching. This may include a nutrient management program that considers the crop nutrient requirements; rate, timing, placement, application method, and form of nutrients applied; nutrient credits for legumes; residual soil nutrients; erosion control practices; filter strips and buffers; water management and irrigation water management.*

The ***Phosphorus Index*** was originally issued as a NRCS South Central Technical Center Technical Note in the early 1990's. An empirical rating is developed for the potential loss of phosphorus from an agricultural field while considering various phosphorus source and transport factors. Montana NRCS issued Agronomy Technical Note No. 77, Phosphorus Index Assessment for Montana. The ratings indicate if quality criteria for phosphorus are being met and can help to identify conservation practices needed for mitigating effects.

The ***Nitrogen Index*** is patterned after the Phosphorus Index incorporating management factors from the discontinued FOCS water quality tools (nitrogen screening tool). Both indices can be used to analyze benchmark conditions and compare results with RMS alternatives. The ratings indicate if quality criteria for phosphorus and nitrogen are being met and can help to identify conservation practices needed for mitigating effects.

The ***Water Quality Indicators Guide Field Sheets*** can also be used to indicate the potential for nutrient loss. The ***Water Quality Indicators Guide (Field Sheets 2B$_1$, 2B$_2$, and 3B)*** provide indications of whether the management of animal wastes or commercial fertilizers has a potential to contaminate surface waters.

The ***Nutrient Storage and Handling Worksheet*** provides an assessment tool that can be used to judge the nutrient risk associated with the storage and handling of commercial fertilizers. Additional worksheets on ***Livestock Waste Storage*** **and** ***Livestock Yard Management*** can be used to judge whether nutrients, organics, and pathogens associated with animal wastes are being properly handled. The worksheets provide a basis for indicating if quality criteria is being met and helps identify practices that need to be considered.

Other Nutrient, Organics and Pathogen References:

<u>Publications</u>

"Agricultural Chemicals Management", NRCS, National Water and Climate Center, October 1996.
"Water Quality Field Guide", USDA/SCS, SCS-TP-160, March 1988.
"Water Quality Indicators Guide", Terrene Institute, Washington, D.C., January 1996.
"Managing Nitrogen for Ground Water Quality and Farm Profitability", Soil Science Society of America, Inc., 1991.
"A Procedure to Estimate the Response of Aquatic Systems to Changes in Phosphorus and Nitrogen Inputs", NRCS, National Water and Climate Center, January 1998.
http://www.wcc.nrcs.usda.gov/wqam/wqam-docs.html
DEQ Circular 9, Montana Technical Standards for Concentrated Animal Feeding Operations.
http://www.deq.mt.gov/wqinfo/Circulars.asp

Training Materials

Nutrient and Pest Management Course and Workbook Materials, NRCS National Employee Development Center, 2001. http://www.wcc.nrcs.usda.gov/pestmgt/nedc/NEDCPM.html
Environmental Management Systems: Surber's publication

Internet Sites

Animal Waste Management Software: http://www.ncg.nrcs.usda.gov/tools/awm.html
Manure Management Planner: http://www.agry.purdue.edu/mmp
Montana MMP template: ftp://ftp-fc.sc.egov.usda.gov/MT/www/technical/agronomy/MMP/MT_CNMP.dot
Nitrogen Leaching and Economic Analysis (NLEAP) Model: http://www.wcc.nrcs.usda.gov/nutrient/nutrient-nitrogen.html

Salinity

The natural weathering process of soil and geologic material produces soluble salt ions. Salt ions are present in varying degrees in all soils and in both ground and surface waters. High soluble salt concentrations are more likely to occur in semi-arid and arid regions where evaporation exceeds precipitation. The salt content of water is usually expressed as the Total Dissolved Salt (TDS) concentration (milligrams/liter (mg/l) or parts per million (ppm)) or as Electrical Conductivity (EC) with units of Decisiemens/Meter (dS/M).

Salt loading (to water bodies) associated with agriculture occurs when irrigation water percolates through a salt-laden soil profile or geologic layer on its way to a stream or ground water, or when irrigation return flows concentrate salts through evapo-transpiration. Loading of salt can also occur with the application of animal and other organic wastes, fertilizers and some pesticides.

Salinity can be detrimental to crop and forage production if concentration in the soil or in applied irrigation water exceed salt tolerance levels for the crops being grown. Salt accumulated from local conditions or conveyed in irrigation water breaks down soil structure and reduces infiltration as well as produces toxic reactions in some crops. Excessive salt concentrations in streams and lakes can also harm freshwater flora and fauna. Dissolved salts can create "osmotic stress" that reduces water available to plants. Total Dissolved Salt (TDS) concentrations can be tolerated by humans up to 2000 mg/l. Livestock can tolerate somewhat higher levels. However, the recommended TDS limit for human consumption is 500 mg/l or approximately 0.7 dS/M. Salts can also cause excessive corrosion of equipment and is especially problematic for irrigation system infra-structure and components.

Salt ions are made up of *anions* ($^-$) of chloride, nitrate, sulfate, carbonate and bi-carbonate combined with *cations* ($^+$) of sodium, potassium, magnesium, and calcium. Salts are highly soluble and readily move with runoff or through leaching. Salinity control, again usually of greatest concern in arid regions, can be achieved through proper irrigation water management and/or animal waste management. Salinity control is complicated because not enough leaching (application of excess irrigation water to dissolve and move soluble salts) can create salt accumulations in the upper soil horizon, which affects crops, whereas too much leaching may cause salt loading in downstream surface water or increasing salinity in ground water.

EC can be used to indicate salt concentration, however the potential concentration of other ions in solution must be considered. Electrical conductivity is measured in millimhos per centimeter or deciSiemens per meter. Specific Conductance (SC) is EC expressed at a uniform temperature of

25 degrees Centigrade. It measures how easy it is to pass an electric current through water. An approximate relationship between EC and TDS is that 650 (mg/l) TDS is equal to 1.0 deciSiemens per meter electrical conductivity.

Electrical conductivity can be used as an indicator of excessive salinity or TDS. Taste can be used as an indicator in lieu of testing for TDS for drinking water. For most crops and freshwater aquatic plants electrical conductivity should be less than 2.0 dS/M to meet quality criteria. Salt tolerances for specific crops can be found in the Montana Irrigation Guide and Montana Environment Technical Note 1. The Water Quality Indicators Guide (WQIG) – Field Sheets 5A and $5B_1$ may be useful in flood or furrow irrigated areas. The RMS target level for salinity using the WQIG is a rating of good or excellent.

Salinity Indicators			
Application	**Indicator**	**RMS Target Level**	**Information Contact**
Human Consumption	Taste or measured TDS concentration or SC	No saline taste or TDS less than 500 mg/l or 0.7 dS/M	
Livestock Consumption	Measured TDS concentration or SC	Threshold for the specific livestock species	see Technical Note Environment MT-1 http://www.mt.nrcs.usda.gov/technical/ecs/environment/technotes
Irrigation water	Irrigated Leaching Index and Salt Management Tool	LI<0.75	See USDA-NRCS NM Agronomy Technical Note #61, June 2001
Irrigation water and surface waters	Measured TDS	Less than 2.0 dS/M or specific values by crop	Montana Irrigation Guide and Tech Note Environment MT-1 National Engineering Handbook – Part 652. http://www.wcc.nrcs.usda.gov/nrcsirrig/irrig-handbooks-part652.html
Flood and furrow irrigated areas	Water Quality Indicators Guide - on Field Sheets 5A and $5B_1$	Ratings of Good to Excellent	Appendix B, or see Water Quality Indicators Guide, Terrene Institute, 1717 K Street NW, Suite 801, Washington, D.C. 20006

Note: *Application of proper irrigation water management and animal waste management is required to overcome potential salinity problems.*

Several companies sell inexpensive electrical conductivity meters including:

Spectrum Technologies, Inc. 1-800-248-8873, http://www.specmeters.com/
Hach Company, 1-800-227-4224, http://www.hach.com/
Extech Instruments, 1-781-890-7440, http://www.extech.com/
YSI Incorporated, 937 767-7241, http://www.YSI.com/

Other Salinity References:

Publications

"Agricultural Salinity Assessment and Management", American Society of Civil Engineers. http://www.pubs.asce.org
"Water Quality Field Guide", USDA/SCS, SCS-TP-160, March 1988.
"Water Quality Indicators Guide", Terrene Institute, Washington D.C., January 1996.
"Animal Waste Management Field Handbook", SCS, 210-AWMFH, 4/92.
"Montana Irrigation Guide", NRCS.

Websites:

Montana Salinity Control Association: http://www.dnrc.mt.gov/cardd/consdist/salinity_control.asp
U.S. Salinity Laboratory: http://www.ars.usda.gov/main/site_main.htm?modecode=53-10-20-00

Heavy Metals

Heavy metals represent another major category of pollutants. Heavy metals are present in the earth's crust, and some are needed in trace amounts to support life processes. Heavy metals can become concentrated in soils and water by agricultural and other activities to the extent they become toxic to organisms. Some of the common heavy metals and trace elements of concern include: aluminum, boron, copper, selenium, lead, mercury, nickel, zinc, arsenic, chromium, cadmium, and molybdenum.

Heavy metals and trace elements can accumulate from atmospheric deposition or as a result of pesticide residues, industrial processes, mineral extraction, or municipal wastes, and from leaching of metal-bearing soils or geologic formations. Application of municipal and food-processing wastes to agricultural land creates the greatest potential accumulating for heavy metal concentrations.

Quality criteria can only be considered met if heavy metals reaching ground water or surface water do not exceed allowable standards. The Montana DEQ should be consulted for the most current permit and practice information available concerning bio-solid application to agricultural land. NRCS should not take the lead in developing a bio-solids management plan. An RMS may include a bio-solids-based nutrient management component if the client has a DEQ-approved plan. All bio-solid applications fall under the U.S. Code, 40 CFR, Parts 403 and 503, General pre-treatment regulations for existing and new sources of pollution and Standards for the Use or Disposal of Sewage Sludge. The management plan should address:

- Bio-solid composition
- Site and soil condition
- Protection of ground and surface water and wells
- Crop rotations or vegetation
- Bio-solid application rates
- Timing of bio-solid application
- Application methods
- Public notification
- Odor management
- Required monitoring.

Heavy Metal Indicators		
Field Application	**RMS Target Level**	**Access**
Application of Municipal and Food Processing Wastes	No exceedance of allowable standards.	DEQ-7, Montana Numeric Water Quality Standards http://www.deq.mt.gov/wqinfo/Standards/CompiledDEQ-7.pdf

Suspended Sediments and Turbidity

Sediment is organic or inorganic material that is in suspension, in transport, or already moved and deposited away from its point of origin. Sediment is considered a pollutant when it concentrates to the point to which it degrades habitat suitability for aquatic organisms, and/or increases turbidity that in turn reduces light penetration and the process of photosynthesis. Turbidity is an expression of the clarity of water. Turbidity in water results from suspended matter such as clay, silt, colloidal materials, organic

matter, or other material that is dissolved or suspended in surface water. Suspended sediment and turbidity are not interchangeable measurements; however, they are different measures of similar processes and have similar effects on the environment. Besides interfering with aquatic life, sediment deposition in water bodies causes reduced water storage capacity, safety hazards for swimming and boating, increased costs for water treatment, and reduced aesthetics.

Sediment is the result of erosion, and suspended sediment is the primary cause of increased turbidity in agricultural streams. Chemicals such as some pesticides, phosphorus, and ammonium are transported with sediment in an adsorbed state. As a result, sediment is a carrier of many other pollutants to surface waters. Over time, changes to the aquatic environment can cause these chemicals to be released from the sediment and contribute to eutrophic or toxic conditions.

Availability of sediment from crop and pastureland is best controlled through erosion control practices. Once soil particles are detached, practices that reduce water flow so that sediment is deposited on site before reaching surface waters are preferred. Examples of practices commonly used to control sediment delivery include residue management, terraces, contoured strips, filter strips and buffers, grassed waterways, irrigation water management, sediment control basins, and tailwater recovery systems.

Other major sources of sediment associated with agriculture stem from erosion of streambanks, ditches and other drainages. Changes in stream flow, channel morphology, and vegetative cover represent some of the contributing factors to bank instability. Grade stabilization structures, waterways, buffers, permanent vegetative cover, proper grazing use, bio-engineering practices, etc., are a few of the conservation practices that might be considered to control streambank erosion and resultant sediment.

Quality criteria for soil erosion including sheet and rill, wind, concentrated flow, classic gully streambank, irrigation induced, soil mass movement, and roadbanks, construction sites, or scour areas should be met in order to control sediment delivery to water bodies.

Physical measurements of either suspended sediments or turbidity are possible and relatively inexpensive. Sampling for use as quality criteria is somewhat problematic. Suspended sediments and turbidity vary over time and space. Often readings are highest during storm events increasing with discharge but can vary depending on local turbulence and velocity. Impacts observed within a given water body may be the result from sources upstream of the property being evaluated. Water quality standards for turbidity and suspended solids are usually measured as a percentage change from baseline conditions. Montana's turbidity standards necessarily vary by stream classification.

Typically, there is a strong relationship between turbidity and suspended sediment; albeit one that is very site or stream specific. Generally about 80 percent of the variability in suspended sediment concentrations can be explained by simultaneous turbidity measurements. Turbidity is measured in either Jackson Turbidity Units (JTU) or Nephelometric Turbidity Units (NTU). NTU can be measured by photoelectric turbidimeters that accurately record lower levels of turbidity and are generally not affected by particle color. Secchi disks are often used to measure turbidity in lakes.

The planner should use professional judgement along with tools like the **Water Quality Indicators Guide Field Sheets** to determine if quality criteria are being met. It is assumed that quality criteria for Soil Erosion must be met in order to be meeting criteria for sediment. Physical measurements using secchi disks and inexpensive pocket turbidimeters over time would add to an individual's professional judgement.

Sediment and Turbidity Indicator Tools	RMS Target Level	Information Contact
Water Quality Indicators Guide Field Sheet 1A: Sediment for Water Courses and Water Bodies Field Sheet 1B: Sediment for Cropland, Hayland or Pasture	Ratings of Good to Excellent	Appendix B, or see Water Quality Indicators Guide, Terrene Institute, 1717 K Street NW, Suite 801, Washington, D.C. 20006
FOTG, Quality Criteria for Erosion	Meets Quality Criteria	FOTG, Section III

Note: *The planned conservation management system must overcome the site and management limitations that create excessive sedimentation and turbidity with practices that control erosion, reduce surface runoff, and/or filter sediment.*

The water quality criterion for sediment is assumed met by meeting the quality criterion for erosion. The ***Water Quality Indicators Guide*** provides additional visual descriptors to help indicate a sediment or turbidity problem. Both water bodies and farm fields should be evaluated. When no ditch, stream, lake, pond, or wetland lie in proximity of the fields being evaluated, the planner must judge likelihood of sediment laden or turbid runoff reaching state waters.

Sediment and Turbidity References:

Publications

"Water Quality Indicators Guide", Terrene Institute, Washington, D.C., January 1996.

Several companies sell inexpensive turbidimeters including:

Ben Meadows Company, 1-800-241-6401, http://www.benmeadows.com/
Hach Company, 1-800-227-4224, http://www.hach.com/
Wildlife Supply Company, 1-800-799-8301, http://www.wildco.com/

Dissolved Oxygen

Dissolved Oxygen (DO) measures the amount of oxygen (O_2) dissolved in water. The amount of O_2 dissolved in water depends upon water temperature, atmospheric pressure, and the surface area exposed to the atmosphere. Major oxygen sources include atmospheric oxygen and photosynthesis of aquatic plants. Oxygen sinks result from respiration and the bio-chemical oxygen demand of substances in the water. The capacity of water to hold oxygen in solution is inversely proportional to the water temperature. Increased water temperature lowers the concentration of DO at saturation. Diurnal (day to night) fluctuations in DO concentrations result from photosynthesis in excess of respiration as the source of oxygen during the day and at night photosynthesis ceases so respiration acts as an oxygen sink.

DO concentrations also can vary between the surface stream water and water flowing through alluvial material in the streambed and banks (known as the hyporeic zone). Oxygen replenishment to these inter-gravel waters comes primarily from the exchange of well-aerated surface waters with oxygen impoverished inter-gravel waters. Low DO within the alluvial materials in the stream bed affects the survival of fish eggs and invertebrates. Clogging of gravel with fine sediment and organic matter is the primary concern affecting this exchange.

Dissolved oxygen is critical to the biological community and for the breakdown of organic matter. In fact, DO, at appropriate concentrations, is essential not only to keeping aquatic organisms alive, but also for sustaining their reproduction, vigor and development. Varying the level of biological diversity in an

aquatic community, such as fish, invertebrates, algae, and bacteria requires different levels of DO for successful existence. Montana water quality standards for DO vary depending on temperature, elevation, and the designated use of the water body as well as the life stage of affected fish species.

Oxygen depletion in streams and lakes is usually associated with excessive temperature, heavy growth of aquatic plants, algal blooms, or high concentrations of organic matter and nutrients. Practices that control excess delivery of sediment, nutrients and organics to surface waters, and that maintain or lower water temperature, and provide good oxygen exchange and aquatic habitat are most effective in maintaining DO levels.

The quality criteria for nutrients, sediment and turbidity, and aquatic habitat and temperature should be used to indicate whether suitable DO levels exist for the benchmark conditions and/or the planned conservation management system. Direct measurement of DO levels with inexpensive test kits may also be used as an indicator if precautions are taken for seasonal and diurnal variability. Measurement of DO levels would be most appropriate in water bodies fully contained within the conservation management unit. Offsite, cumulative effects in flowing waters and larger water bodies make it difficult to estimate the impacts to DO levels from land management activities from one farm or management unit.

Dissolved Oxygen Indicators	RMS Target Level	Information Contact
Direct Measurement where appropriate	Meets state water quality standards	See State Water Quality Standards for details: NM Standards for Interstate and Intrastate Surface Waters
FOTG Quality Criteria for Nutrients, Sediment and Turbidity, Aquatic Habitat and Temperature	Meets Quality Criteria	FOTG, Section III

Several companies sell inexpensive kits and meters for testing dissolved oxygen including:

Ben Meadows Company, 1-800-241-6401, http://www.benmeadows.com/
Hach Company, 1-800-227-4224, http://www.hach.com/
Wildlife Supply Company, 1-800-799-8301, http://www.wildco.com/
YSI Incorporated, 937-767-7241, http://www.YSI.com/

Aquatic/Riparian Habitat and Temperature

Aquatic habitat is included as a water quality parameter because its suitability directly influences a water-body's ability to support aquatic life. Water temperature is included in this category. Riparian habitat with sufficient shade and streams with adequate width/depth ratios (compared to the water-body's potential) are the primary factors affecting temperature. The principal source of heat energy delivered to the water column is solar energy striking the water body. When shaded, far less energy will be imparted to the water body. Shallow, wide streams provide more unit area for solar heating as well as greater opportunity to transfer heat to the stream bed, itself. Hydrologic and geomorphic conditions that impact channel configuration and stream flow are other factors affecting the suitability of aquatic habitat and water temperatures.

Direct measurement of water temperatures is appropriate in water bodies fully contained within the conservation management unit taking care to consider seasonal and diurnal affects. Offsite, cumulative effects in flowing waters and larger water bodies make it difficult to estimate the impacts from land management activities from one farm or management unit on water temperatures. An array of durable, field deployable temperature recording devices are available.

Aquatic/Riparian Habitat Indicator Tools	RMS Target Level	Information
Stream Visual Assessment Protocol	Rating of Good with static trend or Fair with upward trend	NRCS Stream Visual Assessment Protocol (SVAP) http://www.wcc.nrcs.usda.gov/wqam/wqam-docs.html Appendix B includes Summary Sheets.
Montana NRCS Riparian Assessment Procedure	Rating of Sustainable - At Risk (minimum score of 50 percent of potential) with an upward trend	Environment Technical Note No. 2: Riparian Assessment - Using the Montana Riparian Assessment Method. ftp://ftp-fc.sc.egov.usda.gov/MT/www/technical/environment/envtechnoteMT2.pdf. 1
Proper Functioning Condition	Rating of PFC - At Risk with upward trend of lotic (moving water) and lentic (still water) wetland riparian resources	Technical References 1737-15 and 16. A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic and Lentic Areas http://www.blm.gov/or/programs/nrst/technical_notes.php
Temperature Indicator Tools	**RMS Target Level**	**Information**
Individual elements from above Aquatic Habitat Tools • Canopy cover/shade canopy • In-stream fish cover/shelter • Pools	Stream Visual Assessment Protocol rating of Good with static trend or Fair with upward trend	NRCS Stream Visual Assessment Protocol (SVAP) Download from http://www.wcc.nrcs.usda.gov/wqam/wqam-docs.html Appendix B includes Summary Sheets.
Direct measurement of temperature where appropriate	No exceedance of Water Quality Standard. See Montana Numeric Water Quality Standards for details	DEQ, Circular-7, Montana Numeric Water Quality Standards http://www.deq.state.mt.us/wqinfo/Standards/Index.asp

Note: *The planned conservation management system must overcome the site and management limitations that negatively impact aquatic habitat and temperature. This includes practices to restore riparian vegetation, instream habitat, base flow, shade, and hydro-geomorphic functions.*

Several companies sell inexpensive thermometers and temperature recording devices including:

Spectrum Technologies, Inc., 1-800-248-8873, http://www.specmeters.com/
Hach Company, 1-800-227-4224, http://www.hach.com/
Intermountain Environmental, Inc., 1-800-948-6236, http://www.inmtn.com/store/cart.php/
YSI Incorporated, 937 767-7241, http://www.YSI.com/

Reference:

Steam Visual Assessment Protocol, NRCS National Water and Climate Center Technical Note 99-1, November 1998, NRCS, Portland, Oregon

Petroleum Products

Aboveground and underground storage of liquid petroleum products such as motor fuel and heating fuel presents a threat to public health and the environment. Petroleum fuels contain a number of potentially toxic compounds including common solvents such as benzene, toluene, and xylene. Additives such as ethylene dibromide, organic lead compounds and Methyl Tertiary Butyl Ether (MTBE) a very water

soluble compound are potential pollutants found in many petroleum products. MTBE has been found in about 20 percent of nation's urban wells and is considered by the EPA to be a potential carcinogen. Benzene is considered a human carcinogen. Oils affect aquatic organisms by acting on epithelial surfaces of gills interfering with respiration. Oil is detrimental to water fowl by destroying the natural buoyancy and insulation of their feathers. Several important petrochemicals are known to be acutely toxic to fish. At low levels, smell or taste cannot detect fuel contaminants, yet waters may be contaminated to the point of affecting human health or the environment.

In the agricultural setting, improper storage and handling of petroleum products is the most likely source of potential contaminants. According to the EPA, nearly one out of four underground storage tanks (not all occur in the agricultural setting) in the United States may now be leaking. In Montana, there are currently an estimated 3,400 underground storage tanks. Since 1986, 4,189 releases (leaks or spills) have been reported. As of December 15, 2004, there are 1,585 active petroleum releases and 2,604 resolved releases. These known release sites have impacted 78 public water supply wells, 182 private wells, and 33 irrigation wells.

Indicator tools

The Petroleum Storage and Handling Worksheet (Appendix B) may be used to indicate if benchmark conditions and the planned conservation management system meet RMS quality criteria. To meet quality criteria, a ranking of low or low-moderate risk must be obtained.

Appendix A

Water Quality Policy, Rules and Regulations Important to Agriculture

References for water quality policies, rules and regulations are listed in the following tables. Most USDA/NRCS policies can be found in the General Manual or other official agency guides.

The following Internet Web Sites can be queried to locate federal and state rules and regulations relative to water quality.

Federal Web Sites:

http://www.epa.gov/
http://www4.law.cornell.edu/uscode/
http://thomas.loc.gov/

State Web Sites:

http://data.opi.state.mt.us/bills/mca_toc/index.htm
http://www.deq.mt.gov/wqinfo/index.asp

Policy, Rules and Regulations	Reference	Summary
Federal - USDA/NRCS		
USDA Non-point Source Water Quality Policy	Department Regulation 9500-7	Promote the improvement, protection, restoration, and the maintenance of water quality to support beneficial uses.
USDA Ground Water Quality Policy	Department Regulation 9500-8	To protect water users and the natural environment from exposure to harmful substances in ground water, especially in rural areas and to enhance ground water where appropriate
USDA NRCS Water Quality Policy	GM 460-401	Adhere to and support USDA Non-point Source Water Quality Policy by: • recognizing responsibilities of state and local governments. • coordinating activities with conservation districts, private institutions, and other federal, state, and local governments. • emphasizing voluntary actions • targeting financial and technical assistance to solve water quality problems. • supporting monitoring, research, and education to better define resource concerns and effects, to develop technical tools and to train employees.
NRCS National Planning Policy	GM 180-409, GM 450-401, NPPH	The NRCS objective is the sound use and management of soil, air, plant and animal resources to prevent their degradation and assure their sustained use and productivity. Social, cultural, and economic considerations are used to establish the level of natural resource protection obtainable and may constrain the resource criteria used in formulating a resource management system. Where regional, state, and/or local regulations establish more restrictive criteria, these must be used.
Pest Management Policy	GM-190-404, Secretaries Memo No. 1929	Sets the policy, procedures and role NRCS should follow in all pest management activities. This includes promoting the use of integrated pest management methods. It advocates adequate protection against pests while minimizing hazard to humans and the environment.
Nutrient Management Policy	GM 190-402	Sets policy, procedures and role for NRCS technical assistance involving nutrient management and the utilization of organic by-products include animal wastes.

Policy, Rules and Regulations	Reference	Summary
Other Federal		
Clean Water Act of 1972 (CWA)	33 U.S.C. 1251 et seq amended 1977, reauth. 1987	Objective is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.
CWA, Section 303c	33 U.S.C. 1251 et seq amended 1977, reauth. 1987	Requires states to set, review, revise, and enforce water quality standards to protect beneficial uses of water
CWA, Section 303d		Requires states to identify waters that do not meet water quality standards every two years
CWA, Section 305b		Requires states to develop a water quality status assessment report every two years.
CWA, Section 319		Requires states to develop a state water quality management plan to control non-point pollution of the waters of the state. In addition, this section provides grant funds to implement the non-point source management plan.
CWA, Section 401		State water quality certification required where federal actions may result in a discharge to state waters.
CWA, Section 404		Gives the U.S. Corp of Army Engineers the responsibility for regulating the placement of fill or dredge materials in the waters of the United States (404 permit).
CWA, Section 502		Defines Concentrated Animal Feeding Operations (CAFOs) as point sources subject to National Pollution Discharge Elimination System (NPDES) permits.
Safe Drinking Water Act of 1974 (SDWA)	42 U.S.C. s/s 300fd, amended in 1990, 1996 PL 104-170	Objective is to protect public water systems by setting drinking water standards, establishing wellhead protection programs, sole source aquifers, source assessments, providing grant funds, and establishing state revolving funds.
Food Quality Protection Act	7 U.S.C. 136	Provides for stronger, health-based safety standards for pesticide residues in foods. Calls for EPA and USDA to work on promoting integrated pest management.
Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA)	7 U.S.C. s/s 135 et seq	Directs federal control of pesticides through labeling and registration, sale and distribution, applicator certification, worker protection standards, and safe disposal.
Resource Conservation and Recovery Act (RCRA)	42 U.S.C. 6901	Regulates disposal of hazardous wastes including pesticides and construction, maintenance and monitoring of underground storage tanks.
Use of Biosolids (Sludge)	40 CFR, Parts 403 and 503	General pre-treatment regulations and standards for the use or disposal of sewage sludge.

Policy, Rules and Regulations	Reference	Policy, Rules and Regulations
State of Montana		
Montana Water Quality Act	Montana Statutes 75-5-501 et seq. ARM 17.30.101	Established state law concerning water pollution control of both surface and ground waters of the state. It established a basic anti-degradation policy.
Agriculture Chemical Ground Water Protection Act	Montana Statutes 80-15-101	Provides for the management of agricultural chemicals to prevent, minimize, and mitigate their presence in ground water ARM 4.11.101 through 1117.
Montana Water Use Act	Montana Statutes 85-2-101 et seq.	Mandates adjudication of water rights prior to 1973 and requires a permit for new ground and surface water uses to be obtained from the Montana Department of Natural Resources and Conservation.
Montana Pesticides Act	Montana Statutes 80-8-305	The purpose of this act is to regulate in the public interest the labeling, distribution, sale, storage, transportation, application, use, and disposal of pesticides.
Montana Commercial Fertilizer Act	Montana Statutes 80-10-101 and ARM 4.12.601	Provides standards for the registration, manufacture, distribution and supply of commercial fertilizers and soil conditioner products to safeguard the health of humans, animals and plants.
Montana Solid Waste Management Act	Montana Statutes 75-10-201 et seq.	Provides that anyone constructing, operating or closing a solid waste facility must obtain a permit from the Montana Department of Environmental Quality.
Montana Hazardous Waste Act	Montana Statutes 75-10-401 et seq.	Regulations provide standards for identification and listing, generators and transporters, treatment, storage, and disposal of hazardous waste.

Appendix B

Water Quality Indicator Tools

Pesticide Indicator Tools

- **Windows Pesticide Screening Tool Input Form**
- **Water Quality Indicators Guide – Field Sheet 4B – Pesticides**
- **Pesticide Storage, Handling and Disposal Worksheet**

Nutrient Indicator Tools

- **Nitrogen Index Worksheet**
- **Phosphorus Index Worksheet**
- **Water Quality Indicators Guide – Field Sheet 3B – Nutrients**
- **Water Quality Indicators Guide – Field Sheet $2B_1$ – Animal Waste Pasture or Range**
- **Water Quality Indicators Guide – Field Sheet $2B_2$ – Animal Waste Totally or Partially Confined**
- **Assessing the Risk of Ground Water Contamination from Open Lot Animal Feeding Operations**
- **Fertilizer Storage and Handling Worksheet**
- **Nutrients, Organics and Pathogens – Livestock Manure Storage Worksheet**
- **Nutrients, Organics and Pathogens – Livestock Yard Management Worksheet**

Salinity Indicator Tools

- **Water Quality Indicators Guide – Field Sheet 5A – Salinity Indicators for Receiving Water Courses and Water Bodies**
- **Water Quality Indicators Guide – Field Sheet $5B_1$ – Salinity Indicators for Flood and Furrow Irrigated Areas**

Sediment and Turbidity Indicator Tools

- **Water Quality Indicators Guide – Field Sheet 1A – Sediment for Receiving Water Courses and Water Bodies**
- **Water Quality Indicators Guide – Field Sheet 1B – Sediment for Cropland, Hayland or Pasture**

Aquatic Habitat Indicator Tools

- **Stream Visual Assessment Protocol Summary Sheets**
- **Montana NRCS Riparian Assessment Score Sheet**
- **Proper Functioning Condition Summary Sheet**

Petroleum Products Indicator Tool

- **Petroleum Storage and Handling Worksheet**

Windows Pesticide Screening Tool Input Form

Select Soils Screen				
Enter Soil Component Name: **(COMP_NAME) -or-**				
Enter Map Unit Symbol: **(MUSYSM)**				
If soil conditions differ from defaults enter:				
▪ **Slope > 15% (yes or no)**				
▪ **Apparent high water table within 24 in. (yes or no)**				
▪ **Macro-pores in surface horizon deeper than 24" (yes or no)**				
▪ **Organic Matter (%)**				
▪ **Depth 1st Horizon (inches)**				

Select Pesticides Screen				
Enter Active Ingredient -or-				
Enter Product Name:				
Circle Application Type:	Broadcast Banded	Broadcast Banded	Broadcast Banded	Broadcast Banded
Circle Application Method:	Surface Applied Soil Incorporated Foliar Applied	Surface Applied Soil Incorporated Foliar Applied	Surface Applied Soil Incorporated Foliar Applied	Surface Applied Soil Incorporated Foliar Applied
Circle Application Rate: ▪ **Standard(greater than ¼ lb./ac.)** ▪ **Low (1/4 – 1/10 lb. AI)** ▪ **Ultra Low (< 1/10 lb. AI)**	Standard Low Ultra low	Standard Low Ultra low	Standard Low Ultra low	Standard Low Ultra low

Reports Screen		
Cooperator:		
Tract:		
Field:		
Rainfall (circle)	High Probability of runoff or deep percolation within 7-10 days	Low Probability of runoff or deep percolation within 7-10 days
Irrigation (circle)	Low Efficiency significant runoff or deep percolation	High Efficiency insignificant runoff or deep percolation
Residue (circle)	Residues less than 30%	Residues greater than 30%

Field Sheet 4B: Pesticides – Pages 1 of 2
Indicators for Cropland, Hayland, or Pasture

Evaluator: _____ Date: _____
Farm/Field Evaluated: _____ Total Score: _____

(Circle one number among the four choices in each row which BEST describes the conditions of the field or area being evaluated. If a condition has characteristics of two categories, you can "split" a score.)

Rating Item	Excellent	Good	Fair	Poor
1. Erosion Potential	• Not significant • Less than T, little sheet, rill or furrow erosion • No gullies 10	• Some erosion evident • About T, some sheet, rill or furrow erosion • Very few gullies 7	• Moderate erosion • T to 2T • Gullies or furrows from heavy storm events obvious 3	• Heavy erosion • Greater than 2T • Many gullies or furrows and presence of critical erosion areas 0
2. Buffer Zone	• Intervening vegetation between cropland and water course greater than 200 ft. • Type of intervening vegetation ungrazed woodland, brush, or herbaceous plants 8	• Intervening vegetation between cropland and watercourse 100 to 200 ft. • Type of intervening vegetation grazed woodland, brush, or herbaceous plants or range 6	• Intervening vegetation between cropland and watercourse 50 to 100 ft. • Type of intervening vegetation high density cropland 4	• Cropping from less than 50 ft. up to water's edge • Type of intervening vegetation low density cropland or bare soil 2
3. Appearance of non-target vegetation	• No leaf burn • No evidence of dieback 9	• Some leaf burn • No dieback 6	• Significant leaf burn • Some vegetation dieback 4	• Severe dieback of vegetation 1
4. Runoff Potential	• Low • Runoff Curve Number (RCN) 61 – 70 • Very flat to flat terrain (0-0.5% slope) • Rainfall (less than 8") • Even, gentle impact (scatter shower-type) of rainfall 10	• Moderate • RCN 71 – 80 • Flat to gently sloping (0.5-2.0% slope) • Rainfall (8-15") • Even, gentle to moderate intensity rainfall 8	• Considerable • RCN 81 - 90 • Gently to moderately sloping (2-5% slope) • Rainfall (16-22") • Even but intense rainfall 4	• High • RCN greater than 90 • Moderately sloping to steep (greater than 5%) • Rainfall (more than 22") • Intense uneven rainfall in season when soil is exposed 0
5. Type of pesticide	• Narrow spectrum, species specific • Water soluble, very rapidly degrading 8	• Fairly narrow range of toxicity • Water soluble, rapid to moderate degradation 5	• Persistent, not species specific • Fat soluble, non - biodegradable 3	• Persistent, wide spectrum biocide • Fat soluble, non - biodegradable 1
6. Pesticide management including amount of pesticide applied per acre; the frequency of application, timing and manner of application; and clean-up practices	• Application according to a well defined pest management program such as Integrated Pest Management (IPM) with close supervision by professional • Insecticides applied once every two years. One herbicide treatment per year • Careful non-aerial spraying or incorporating into the soil • Spraying on dry, hot, windless days • Follows instruction on pesticide label. Discards containers at appropriate disposal centers • Uses a professional applicator 10	• Application of recommended dosages by certified applicators based on scouting by professionals • Insecticides applied twice per year. Two herbicides treatments per year OR • Insecticides and herbicides applied as needed • Careful non-aerial or aerial spraying • Spraying on calm, dry days • Careful to avoid spills • Careful to keep containers away from water body 7	• Application based on scouting by the landowner; extra pesticide beyond the recommended dosage to insure pest control • Insecticides applied two to five times per year. Two to three herbicide treatments per year • Casual non-aerial or aerial spraying • Spraying with minimal concern about the weather • Containers discarded haphazardly. Containers washed in a water body or in close proximity to the water so that contamination is likely 3	• Application by a schedule that meets the needs of the landowner. No scouting • Landowner strives for zero pests by doubling or more than doubling the application rate. • Insecticides applied more than five times per year. More than three herbicide treatments per year. • Application almost exclusively aerial • Spraying with no heed to the weather. Application on windy, rainy days common • Careless discarding of containers in water bodies. Doesn't heed warnings for human safety with regard to application, cleanup or disposal 0

Field Sheet 4B: Pesticides – Pages 2 of 2
Indicators for Cropland, Hayland, or Pasture

7. Potential for ground water contamination	• Low • Soil rich to very rich in organic matter (>3.0%) • Slow to very slow percolation in heavy texture soils such as clays, silty or sandy clays, or silty clay loams • Perched water table present • In protected bedrock areas (50 ft. of soil and shale cap), well depth is 75-100 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is greater than 150 ft. • In shallow bedrock areas (25-50 ft. soil and shale cap), well depth grater than 200 ft. • In Karst areas, well depth is greater than 1,000 ft. if aquifer is confined 9	• Moderate • Soils rich to moderate in organic matter (3.0 to 1.5%) • Slow to moderate percolation in clay loams or silts • Perched water table present • In protected bedrock areas, well depth is 30-74 ft. • In protected bedrock area overlain with 50 ft. of sand or gravel, well depth is 100 to 149 ft. • In shallow bedrock areas, well depth is 50-199 ft. • In Karst areas, well depth is 500-999 ft. 6	• Considerable • Soils moderate to low in organic matter (1.5 to 0.5%) • Moderate to rapid percolation in silty loams, loams, or silts • In protected bedrock areas, well depth is 15-29 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is 50-99 ft. • In shallow bedrock areas, well depth is 25-49 ft. • In Karst areas, well depth is 100-499 ft. 4	• High • Soils low to very low in organic matter (less than 0.5%) • Rapid percolation in coarse textured loam sands or sands • In protected bedrock areas, well depth is less 15 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is less than 50 ft. • In shallow bedrock areas, well depth is less than 25 ft. • In Karst areas, well depth is less than 100 ft. 0
1. Add the circled Rating Item scores to get a total for the field sheet			TOTAL	
2. Circle the ranking for this site based on the total field score.				
RANKING	Excellent (54-64)	Good (35-53)	Fair (14-34)	Poor (13 or less)

Pesticide Storage, Handling, and Disposal Worksheet

Ground and Surface Water Contaminants - Pesticides - Pesticide Storage, Handling, and Disposal					
Farm:					
Rating Item	**Low Risk 4 Points**	**Low-Moderate Risk 3 Points**	**Mod-High Risk 2 Points**	**High Risk 1 Point**	**Score**
1. Amount stored	No pesticides stored at any time	Less than one gallon or less than ten pounds of pesticide	More than one gallon or more than ten pounds of each pesticide	More than 55 gallons or more than 550 pounds of pesticide	
2. Formulation	All dry	Mostly dry (>50%)	Mostly liquid (>50%)	All liquid	
3. Storage Area	Impermeable surface with curbs to contain leaks and spills	Impermeable surface with no curbs or curbed but cracks in floor	Permeable surface (wooden floor)	Permeable surface (dirt or gravel floor)	
4. Containers	Original containers clearly labeled and in good condition (no holes, tears, or weak seams)	Original containers in fair condition but with labels partially missing or hard to read	Containers old showing signs of wear. Metal containers showing signs of rusting.	Containers old with holes, tears, weak seams, and **no labels**.	
5. Mixing and loading pad (spill containment)	Concrete pad with curb keeps spills contained. Sump allows collection and transfer to storage.	Concrete pad with curb keeps spills contained. No sump.	Concrete pad with some cracks keeps some spills contained. No curb or sump.	No mixing/loading pad. Permeable soil (sand). Spills soak into ground.	
6. Location of mixing and loading areas	Impermeable surface with curbs; spills collected; 100 ft. or more down slope from well	Permeable surface 50-100 ft. down slope from well	Permeable surface between 10-50 ft. down slope from well	Within ten ft. down slope or within 100 feet upslope from well	
Backflow prevention/Fill Supervision	Anti-backflow device installed and 6-inch air gap maintained/Constant	Anti-backflow device installed. Hose in tank above waterline/Nearly constant	No anti-backflow device. Hose in tank above waterline/Frequent	No anti-backflow device. Hose in tank below waterline/ Seldom or never	
7. Handling	Closed system for all liquid and dry product transfers	Closed system for most liquids, some liquid and dry products hand poured, sprayer fill port easy to reach	All liquids and dry products hand poured, sprayer fill port easy to reach	All liquids and dry products hand poured, sprayer fill port hard to reach	
8. Sprayer cleaning and rinsate (rinse water) disposal	Sprayer washed out in field. Rinsate used in next load and applied to labeled crop.	Sprayer washed out on pad at farmstead. Rinsate used in next load and applied to labeled crop.	Sprayer washed out at farmstead. Rinsate sprayed less than 100 ft. from well.	Sprayer washed out at farmstead. **Rinsate dumped at farmstead or in field.**	
9. Container disposal	Triple-rinsed containers returned to dealers or taken to licensed landfill or municipal incinerator. Bags returned to supplier or hazardous waste collection service used.	Un-rinsed containers and empty bags taken to licensed landfill, municipal incinerator or dump.	Disposal of un-rinsed containers or empty bags on farm. Disposal of triple-rinsed containers on farm. **Disposal of container in a manner inconsistent with the label.**	Disposal of partially filled plastic or paper containers on farm. **Disposal of container in a manner inconsistent with the label.**	
Pesticide Handling Rating		Accumulative Score (Sum of above rating items)			
		Average Score (Accumulative/9)			

Ratings: 3.6-4=Low risk, 2.6-3.5=Low to moderate risk, 1.6-2.5=Moderate to high risk, 1-1.5=High Risk

Boldface type: violates Montana Pesticides Act (80-8-305)

Source: Modification of Montana Farm*A*Syst, Worksheet #2, Pesticide Storage and Handling

Nitrogen Index – Pages 1 of 2

Index Items Transport Factors	Factor Weight	None (0)	Low (1)	Medium (2)	High (4)	Very High (8)	Surface Loss Rating (Col* factor weight)	Leaching Loss Rating (Col* factor weight)
Runoff Class	1.0	Negligible and Very Low (0)	Low (1)	Medium (2)	High (4)	Very High (8)		
Permeability Class	1.0	Imperme-able to Very Slow (<0.0015 to 0.06 in/hr) (0)	Slow to Moderately Slow (0.06 to 0.6 in/hr) (1)	Moderate (0.6 to 2 in/hr) (2)	Moderately Rapid to Rapid (2-20 in/hr) (4)	Very Rapid (>20 in/hr) (8)		
Annual Precipitation	1.0	<8” (0)	8-15” (1)	16-22” (2)	23-30” (4)	>30” (8)		
Irrigation Water Management	1.0	None (0)	Insignificant runoff and/or deep percolation – total amount applied = consumptive use; follows 449 standard (1)	Little runoff and/or deep percolation – total amount applied does not exceed 110% of consumptive use (2)	Some runoff and/or deep percolation – total amount applied does not exceed 125% of consumptive use (4)	Significant runoff and/or deep percolation – total amount applied exceeds 125% of consumptive use (8)		
Water runoff management	1.0	Grasses, perennial vegetation CRP (0)	No-till and/or strips/ Terraces plus buffers, filter strips or tailwater recovery (1)	Residue management (>30% at planting) and/or strips/terraces (2)	Conventional Tillage, some residue (4)	Fallow condition, no residue (8)		
Irrigation Erosion[1/]	1.0	Not Irrigated or No Furrow Irrigation (0)	Tailwater recovery or QS>6 for very erodible soils or QS<10 for other soils (1)	QS>10 for erosion resistant soils (2)	QS>10 for erodible soils (4)	QS>6 for very erodible soils (8)		
Distance[2] to Surface Water body	1.0	>1000’ (0)	500 to 1000’ (1)	200’ to 500’ (2)	30’ to 200’ (4)	<30’ (8)		
Distance[2] to Aquifer	1.0	>150’ (0)	99’ to 150’ (1)	20’ to 99’ (2)	10’ to 19’ (4)	<10’ (8)		

[1/]QS Note: Q = flow rate of water introduced into the furrow (in gallons per min.), S = furrow slope (in ft./100 ft., percent).
Q is multiplied by S. For example: 5 gpm x 2% = 10.
[2/]Distance measured from edge of field to surface water body or bottom of root zone to an aquifer (usable water supply not to a seasonal high water table).

Nitrogen Index – Pages 2 of 2

Index Items Source Factors	Factor Weight	None (0)	Low (1)	Medium (2)	High (4)	Very High (8)	Surface Loss Rating (Col* factor weight)	Leaching Loss Rating (Col*factor weight)
Application Rate	1.5	None applied (0)	Nitrogen applied at agronomic rates with soil test; follows 590 standard (1.5)	Nitrogen applied at rates greater than 100 to 150% of agronomic rates; with soil test (3)	Nitrogen applied at rates over 150% of agronomic rates; with soil test (6)	Nutrients applied with no soil test (12)		
Application Form	1.0	None applied (0)	Commercial fertilizer w/calibrated application equipment (1)	Commercial fertilizer but w/o calibration of application equipment Or Organic w/ manure test and calibrated application (2)	Organic w/manure Test but w/o calibrated application equipment (4)	Organic w/o manure test or calibration of application equipment (8)		
Commer-cial Fertilizer Timing (and/or)	1.0	None applied (0)	Grid or zone sampling; precision application (1)	Spring application and/or top dressed during growing season (2)	Split applications on fall seeded crops (starter in fall/top dressed spring/summer) (4)	Application more than one month ahead of planting or broadcast on frozen or snowcovered ground (8)		
Organic Fertilizer Timing	1.0	None applied (0)	Incremental application applied as crop uses N throughout year (1)	All manure applied less than one month before planting (2)	Application more than one month ahead of planting (4)	Application in winter months (December and January) (8)		
Application Method	1.0	None applied (0)	Banded/ injected or precision applied (1)	Broadcast/ surface applied, incorporated within 5 days (2)	Broadcast/surface applied, incorporated more than 5 days (4)	Surface applied, not incorporated (8)		
				Total Weighted Rating (Sum of Columns)				
				Rating			Surface Water	Ground Water
						Low Potential	<17	<14
						Medium Potential	17 to 34	14 to 28
						High Potential	34 to 68	28 to 58
						Very High Potential	>68	>58

Source: Oregon NRCS as modified by Montana NRCS

PHOSPHORUS INDEX ASSESSMENT WORKSHEET

SITE CATEGORY FACTOR	NONE (0)	LOW (1)	MEDIUM (2)	HIGH (4)	VERY HIGH (8)	RISK VALUE (0,1,2,4,8)	WEIGHT FACTOR	WEIGHTED RISK FACTOR
Soil Erosion	N/A	<5 ton/ac/yr	5-10 tons/ac/yr	10-15 tons/ac/yr	>15 tons/ac/yr		X 1.5	
Furrow Irrigation Erosion	N/A	Tailwater recovery, QS >6 very erodible soils, or QS >10 other soils	QS >10 for erosion resistant soils	QS >10 for erodible soils	QS >6 for very erodible soils		X 1.5	
Sprinkler Irrigation Erosion	All sites 0-3% slope, all sandy sites, or site evaluation indicates little or no runoff, large spray on silts 3-8%	Medium spray on silty soils 3-15% slopes, large spray on silty soils 8-15% slope, low spray on silt soils 3-8%, large spray on clay soil 3-15% slope	Medium spray on clay soils 3-8% slopes, large spray on clay soils >15% slope, medium spray on silt soil >15% slope	Medium spray on clay soils >8% slope, low spray on clay soil 3-8% slope, low spray on silty soils >15% slopes	Low spray on clay soils >8% slopes		X 0.5	
Runoff Class	Negligible	Very Low or low	Medium	High	Very High		X 0.5	
Olson Soil Test P	---	<20 ppm	20-40 ppm	40-80 ppm	>80 ppm		x 1.0	
Commercial P Fertilizer Application Method	None Applied	Placed with planter or injected deeper than 2 inches.	Incorporated <3 months prior to planting or surface applied during the growing season.	Incorporated >3 months before crop or surface applied <3 months before crop emerges.	Surface applied >3 months before crop emerges.		X 1.0	
Commercial P Fertilizer Application Rate	None Applied	<30 lbs/ac P_2O_5	31–90 lbs/ac P_2O_5	91–150 lbs/ac P_2O_5	>150 lbs/ac P_2O_5		X 1.0	
Organic P Source Application Method	None Applied	Injected deeper than 2 inches	Incorporated <3 months prior to planting or surface applied during growing season.	Incorporated <3 months before crop or surface applied <3 months before crop emerges.	Surface applied to pasture or >3 months before crop emerges.		X 1.0	
Organic P Application Rate	None Applied	<30 lbs/ac P_2O_5	31–90 lbs/ac P_2O_5	91–150 lbs/ac P_2O_5	>150 lbs/ac P_2O_5		X 1.0	
Distance to Concentrated Surface Water Flow	>1,000 feet	200-1,000 feet, or functioning grasses waterways in concentrated surface water	100-200 feet	<100 feet	0 feet or applications are directly into concentrated surface water flow areas.		X 1.0	
Site/Field Total Phosphorus Index Value								

Field Sheet 3B: Nutrients – Pages 1 of 2

Indicators for Cropland, Hayland, or Pasture

Evaluator: _____ Date: _____

Farm/Field Evaluated: _____ Total Score: _____

(Circle one number among the four choices in each row which BEST describes the conditions of the field or area being evaluated. If a condition has characteristics of two categories, you can "split" a score.)

Rating Item	Excellent	Good	Fair	Poor
1. Erosion Potential	• Not significant. • Less than T (tolerance) little sheet and rill erosion, no gullies. • Blocky, platy or massive soil structure. 10	• Some erosion evident. • About T, some sheet and rill erosion. Very few gullies. • Coarse granular to medium granular soils. 6	• Moderate erosion. • T to 2T gullies from heavy storm events obvious. • Fine granular soils. • Potentially highly erodible soils. 3	• Heavy erosion. • More than 2T, many gullies and critical erosion areas. • Very fine granular soils, highly erodible. 0
2. Runoff Potential	Low: • Soils Hydrologic Group A. • Very flat to flat terrain (0.5-2% slope). • Rainfall (less 8"). • Even, gentle impact (scattered shower-type) of rainfall. 10	Moderate: • Soils Group B. • Flat to gently sloping (0.5-2% slope). • Rainfall (8-15"). • Even, gentle to moderate intensity rainfall. 8	Considerable: • Soils Group C. • Gentle to moderately sloping (2-5% slope). • Rainfall (16-22"). • Even but intense rainfall. 4	High • Soils Group C. • Moderately sloping to steep terrain (greater than 5%). • Rainfall (more than 22"). • Intense uneven rainfall in seasons when soil is exposed. 2
3. Resource Management Systems on whole farm (combined value for all agricultural areas pastureland, cropland, or animal holding areas)	• Excellent Management. • RMS always used as needed. 9	• Good management. • Most (80%) of the needed RMSs installed. • Predominance of farming practices diverting runoff away from receiving waters (terraces without tile drains). 7	• Rain management. • About 50% of the needed RMSs installed. • Cropping confined to proper land class. • Predominance of farming practices diverting runoff toward receiving waters (tile drains and field ditches). 3	• Poor management. • Few, if any, needed RMSs installed. • Cropping not confined to proper classes. • No diversion of runoff water; water flowing directly into receiving waters. 0
4. Buffer Zone	• Cropland is more than 600 ft. from water with intervening herbaceous vegetation (grass). • Cropland is less than 100 ft., but more than 50 ft. from water with intervening vegetation (trees). 10	• Cropland is less than 200 ft. but more than 15 ft. from water with intervening herbaceous vegetation (grass). • Cropland is less than 50 ft. but more than 15 ft. from water with intervening woody vegetation (trees). • Little bank (riparian) vegetation. 7	• Cropping up to the water's edge. • No bank (riparian) vegetation. 0	0
5. Fertilizer Management Practices	• Excellent management. • No fertilizer necessary. • Well defined schedule as to frequency and timing for inorganic or organic fertilizer depending on crop type, height of growth, etc. • Application of exactly the proper (recommended) amounts according to soil tests. Pays close attention to weather forecasts. Never applies before a storm. • Fertilizer is incorporated into the soil. 9	• Good management. • Mainly follows a schedule but sometimes missed the best timing for the maximum utilization by the crop. • Usually follows directions for proper dosages of fertilizer and has soil tested regularly. Follows weather forecasts but once in a while will risk applying when rain is forecast. • Fertilizer is mainly of the incorporated slow-release type. 7	• Haphazard management. • Follows a schedule about half the time. • Application is based on convenience. Tends to "over fertilize" by using more than the recommended dose as "insurance." • Occasionally loses much of application in a washout. • More than half the fertilizer is applied to the surface. 3	• Little or erratic management. • Seldom follows a schedule. • Applications without heed to weather forecasts. Often loses most of the applied fertilizer in a washout. Applies usually too little, sometimes too much. • Most of the fertilizer is surface applied without incorporation. 0

Field Sheet 3B: Nutrients – Pages 2 of 2
Indicators for Cropland, Hayland, or Pasture

6. Potential for ground water contamination	Low: • Soils rich to very rich in organic matter (>3.0%). • Slow to very slow percolation in heavy textured soils such as clays, silty or sandy clays, or silty clay loams. • Perched water table present. • In protected bedrock areas (50 ft. of silt and shale cap), well depth is 75-100 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is greater than 150 ft. • In shallow bedrock areas (25-50 ft. soil and shale cap), well depth greater than 200 ft. • In Karst areas, well depth is greater than 1,000 ft., if aquifer is "confined." 9	Moderate: • Soils rich to moderate in organic matter (3.0 to 1.5%). • Slow to moderate percolation in clay loams or silts. • Perched water table present. • In protected bedrock areas, well depth is 30-74 ft. • In protected bedrock area overlain with 50 ft. of sand or gravel, well depth is 200-149 ft. • In shallow bedrock areas, well depth is 50-199 ft. • In Karst areas, well depth is 500-999 ft. 6	Considerable: • Soils moderate to low in organic matter (1.5 to 0.5%). • Moderate to rapid percolation in silty loams, loams, or silts. • In protected bedrock areas, well depth is 15-29 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel well depth is 50-99 ft. • In shallow bedrock areas, well depth is 25-49 ft. • In Karst areas, well depth is 100-499 ft. 4	High: • Soils low to very low in organic matter (less than 0.5%). • Rapid percolation in coarse textured loamy sand or sands. • In protected bedrock areas, well depth is less than 15 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is less than 50 ft. • In shallow bedrock areas, well depth is less than 25 ft. • In Karst areas, well depth is less than 100 ft. 0
1. Add the circled Rating Item scores to get a total for the field sheet.			TOTAL	
2. Circle the ranking for this site based on the total field score.				
RANKING	Excellent (49-57)	Good (30-48)	Fair (9-29)	Poor (8 or less)

Field Sheet 2B$_1$: Animal Waste – Page 1 of 1
Indicators for Pasture or Range Animals

Evaluator: _____ Date: _____
Farm/Field Evaluated: _____ Total Score: _____

(Circle one number among the four choices in each row which BEST describes the conditions of the field or area being evaluated. If a condition has characteristics of two categories, you can "split" a score.)

Rating Item	Excellent	Good	Fair	Poor
1. Runoff Potential	Low: • Runoff Curve Number (RCN) 61-70. • Very flat to flat terrain (0-5% slope). • Rainfall (< 8"). • Even, gentle impact (scattered shower-type) of rainfall. 10	Moderate: • RCN 71-80. • Flat to gently sloping (0.5-2.0% slope). • Rainfall (8-15"). • Even, gentle to moderate intensity rainfall. 8	Considerable: • RCN 81-90. • Gently to moderately sloping (2-5% slope). • Rainfall (16-22"). • Even but intense rainfall. 4	High: • RCN greater than 90. • Moderately sloping to steep (> 5%). • Rainfall (more than 22") • Intense uneven rainfall in seasons when soil is exposed. 0
2. Un-grazed Buffer Zone	• Pasture or range with a strip of intervening vegetation greater than 200 ft. 9	• Pasture or range with 50 to 200 ft. strip of intervening vegetation. 7	• Pasture or range with 10 to 50 ft. of intervening vegetation. 3	• Pasture or range in close proximity to edge or adjacent to water course. 2
3. Rate of Waste Decomposition	• Rapid decomposition of waste due to hot, sunny climate. 9	• Moderate to rapid decomposition due to warm sunny climate. 7	• Slow to moderate decom-position due to cooler, more overcast climate. 3	• Slow decomposition due to cold climate with little direct solar radiation. 2
4. Pasture or Range Management	Excellent: • 90% cover. • Proper grazing. • Animal numbers within the carrying capacity • No fertilization or pH adjustment and application of recommended amounts of fertilizer for maximum forage utilization based on soil tests. 9	Good: • 70-90% cover. • Occasional bare areas. • Animals exceed carrying capacity only 1 to 2 times per year. • No fertilization or recommended amounts for maximum forage utilization. 6	Fair: • 50-70% cover. • Some bare spots. • Animals exceed carrying capacity over 25% of the year. • Fertilization at greater than recommended amounts for forage utilization. 3	Poor: • 50% or less cover. • Numerous bare spots. • Animal numbers exceed carrying capacity 100% of year. • Significant over-application of animal waste or commercial fertilizer close to water's edge. 0
5. Potential for ground water contamination	Low: • Soils rich to very rich in organic matter (>3%). • Slow to very slow percolation in heavy-textured soils such as clays, silty or sandy clays, or silty clay loams. • Perched water table present. • In protected bedrock areas (50 ft. of soil and shale cap) well depth is 75-100 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is greater than 150 ft. • In shallow bedrock areas (25-50 ft. soil and shale cap), well depth greater than 200'. • In Karst areas, well depth is greater than 1,000 ft. if aquifer is "confined." 9	Moderate: • Soils rich to moderate in organic matter (3.0 to 1.5%). • Slow to moderate percolation in clay loams or silts. • Perched water table present. • In protected bedrock areas, well depth is 30-74 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is 100-149 ft. • In shallow bedrock areas, well depth is 50-199 ft. • In Karst areas, well depth is 500-999 ft. 6	Considerable: • Soils moderate to low in organic matter (1.5 to 0.5%). • Moderate to rapid percolation in silty loams, loams, or silts. • In protected bedrock areas, well depth is 15-29 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is 50-99 ft. • In shallow bedrock areas, well depth is 25-49 ft. • In Karst areas, well depth is 100-499 ft. 4	High: • Soils low to very low in organic matter (< 0.5%). • Rapid percolation in coarse-textured loamy sands or sands. • In protected bedrock areas, well depth is less than 15 ft. • In protected bedrock 50 ft. of sand or areas overlain with gravel, well depth is less than 50 ft. • In shallow bedrock areas, well depth is less than 25 ft. • In Karst areas, well depth is less than 100 ft. 0
1. Add the circled Rating Item scores to get a total for the field sheet			TOTAL	
2. Circle the ranking for this site based on the total field score.				
RANKING	Excellent (40-46)	Good (25-39)	Fair (10-24)	Poor (9 or less)

Field Sheet 2B$_2$: Animal Waste – Pages 1 of 2
Indicators for Totally or Partially Confined Animals

Evaluator: _____ Date: _____
Farm/Field Evaluated: _____ Total Score: _____

(Circle one number among the four choices in each row which BEST describes the conditions of the field or area being evaluated. If a condition has characteristics of two categories, you can "split" a score.)

Rating Item	Excellent	Good	Fair	Poor
1. Runoff Potential	Low: • Runoff Curve Number (RCN) 61-70. • Very flat to flat terrain (0-0.5% slope). • Rainfall (less than 8"). • Even, gentle impact (scattered shower-type) of rainfall. 10	Moderate: • RCN 71-80. • Flat to gently sloping (0.5-2.0% slope). • Rainfall (8-15"). • Even, gentle to moderate intensity rainfall. 8	Considerable: • RCN 81-90. • Gently to moderately sloping (2-5% slope). • Rainfall (16-22"). • Even but intense rainfall. 4	High: • RCN greater than 90. • Moderately sloping to steep (greater than 5%). • Rainfall (more than 22"). • Intense uneven rainfall in seasons when soil is exposed. 0
2. Animal waste yield to water body; proportion of waste to leave the site	• Site is 800 ft. from water body with intervening vegetation. • Rapid decomposition of waste due to hot, sunny climate or low pH soils. 10	• Site is between 200-500 ft. from water with intervening vegetation. • Moderate to rapid .decomposition due to warm, sunny climate. 8	• Site 200 ft. from water. • Slow to moderate decomposition due to cooler, more overcast climate. 4	• Site is on bank of water body or in close proximity to it. • Slow decomposition due to cold climate with little direct solar radiation or high pH soils. 0
3. Animal access to water	• None to very little. Watering areas located far from naturally occurring water bodies. 9	• Very limited. Watering away from stream or pond. Stream used only as access path. 7	• Access limited to watering. 3	• Unlimited access for both watering and cooling. 0
4. Runoff Management	Excellent management: • Runoff is completely diverted away from concentrated waste. BMPs used as needed, such as surface water diversions, including guttering. 10	Good management: • A good portion of clean runoff is diverted from waste. Runoff from feedlot, barns, etc., is diverted to holding pond. 7	Fair management: • Only a partial runoff management system. Evidence of contaminated runoff going directly to streams or ponds. 3	Poor management: • Little or no runoff management. Natural runoff removes most of the waste or little to no management of lagoons results in recurrent overflows. Evidence of lagoon overflows, manure-caked flow paths, etc. 0
5. Waste handling and utilization practices	Excellent management Always with: • Established collection schedule. • Application at proper rates and times. • Control of odor and pests. • Regular sampling and record keeping. • More than sufficient acreage for waste utilization. 10	Good management most of the time (80%) with some of the following: • Established collection schedules. • Application at proper rates and times. • Control of odor and pests. • Sufficient acreage for waste utilization. 8	Haphazard management common: • Collection random. • Applies waste anytime even before predicted rainfall. • Odor and pests as occasional problems. • Insufficient acreage for waste utilization. 4	No or little management. • A real mess most of the time. • Continual odor and waste accumulation problems. 0

Field Sheet $2B_2$: Animal Waste – Pages 2 of 2
Indicators for Totally or Partially Confined Animals

6. Potential for ground water contamination	Low: • Soils rich to very rich in organic matter (>3.0%). • Slow to very slow percolation in heavy-textured soils such as clays, silty or sandy clays or silty clay loams. • Perched water table present. • In protected bedrock areas (50 ft. of soil and shale cap), well depth is 75-100 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is greater than 150 ft. • In shallow bedrock areas (25-50 ft. soil and shale cap), well depth greater than 200 ft. • In Karst areas, well depth is greater than 1,000 ft. if aquifer is "confined." 9	Moderate: • Soils rich to moderate in organic matter (3.0 to 1.5%). • Slow to moderate percolation in clay loams or silts. • Perched water table present. • In protected bedrock areas, well depth is 30-74 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is 100-149 ft. • In shallow bedrock areas, well depth is 50-199 ft. • In Karst areas, well depth is 500-999 ft. 6	Considerable: • Soils moderate to low in organic matter (1.5 to 0.5%). • Moderate to rapid percolation in silty loams, loams, or silts. • In protected bedrock areas, well depth is 15-29 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is 50-99 ft. • In shallow bedrock areas, well depth is 25-49 ft. • In Karst areas, well depth is 100-499 ft. 4	High: • Soils low to very low in organic matter (less than 0.5%). • Rapid percolation in coarse-textured loamy sands or sands. • In protected bedrock areas, well depth is less than 15 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is less than 50 ft. • In shallow bedrock areas, well depth is less than 25 ft. • In Karst areas, well depth is less than 100 ft. 0
1. Add the circled Rating Item scores to get a total for the field sheet			TOTAL	
2. Circle the ranking for this site based on the total field score.				
RANKING	Excellent (51-58)	Good (33-50)	Fair (11-32)	Poor (10 or less)

Assessing the Risk of Ground Water Contamination from Open Lot Management on Animal Feeding Operations (AFOs)

Criteria Summary Sheet

1. Soil Depth/Depth to Bedrock*

- □ Low Risk: Deep to moderately deep ≥ 60 inches deep/depth to bedrock.
- □ High Risk: Shallow < 60 inches deep/depth to bedrock.

2. Soil Texture*

- □ LOW RISK: FINE TO MEDIUM TEXTURE - LOAM, SILT LOAM, CLAY LOAM, CLAY, FINE SANDY LOAM, VERY FINE SAND.
- □ HIGH RISK: COARSE TEXTURE - COARSE SAND AND GRAVEL, SAND, SANDY LOAM, LOAMY SAND

3. Permeability or Hydraulic Conductivity*

- □ LOW RISK: IMPERMEABLE TO MODERATELY SLOW: < 0.6 INCHES/HOUR.
- □ HIGH RISK: MODERATE TO VERY RAPID: ≥ 0.6 INCHES/HOUR).

OR

SATURATED HYDRAULIC CONDUCTIVITY: (K_{SAT}) RATINGS

- □ LOW RISK: VERY LOW TO MODERATELY LOW: K_{sat} < 0.1417 INCHES/HOUR (< 0.360 CM/HR).
- □ HIGH RISK: MODERATELY HIGH TO VERY HIGH: K_{sat} ≥ 0.1417 INCHES/HOUR (≥ 0.360 CM/HR).

4. Hydrologic Group

- □ LOW RISK – HIGH RUNOFF POTENTIAL: HYDROLOGIC GROUPS C AND D.
- □ HIGH RISK – LOW RUNOFF POTENTIAL: HYDROLOGIC GROUPS A AND B.

5. Depth to Water Table*

- □ LOW RISK: > 60 FEET TO GROUND WATER; OR
  > 40 FEET AND HIGH RISK FOR CRITERIA #2 AND 3; OR
  > 20 FEET AND LOW RISK FOR CRITERIA #2 AND 3.
- □ HIGH RISK: < 20 FEET TO GROUND WATER AND HIGH RISK FOR CRITERIA #2 AND 3; OR < 10 FEET TO GROUND WATER.

6. Distance to Well*

- □ LOW RISK: ≥ 150 FEET TO A WATER WELL OR THE WELL IS HYDRAULICALLY AND TOPOGRAPHICALLY UP-GRADIENT OF THE OPEN LOT.
- □ HIGH RISK: < 150 FEET TO A WATER WELL REGARDLESS OF GRADIENT.

7. Earthen Lot Cleaning Frequency

- □ LOW RISK: CLEANED ONE OR MORE TIMES PER YEAR UNDER CONTINUOUS USE CONDITIONS OR CLEANED AFTER EACH USE PERIOD WHEN NOT USED CONTINUOUSLY.
- □ HIGH RISK: CLEANED LESS THAN ONE TIME PER YEAR OR NEVER.

8. Manure Pack Management

- □ LOW RISK: LEAVES 1 TO 2 INCHES WHEN CLEANING OPEN LOT SURFACE.
- □ HIGH RISK: SCRAPED TO MINERAL SOIL EACH CLEANING.

9. Topography

- ☐ LOW RISK: THE LOT HAS A UNIFORM SLOPE OF 2 TO 6 PERCENT TO DRAIN PRECIPITATION AND DRY THE LOT SURFACE EVENLY. LIMITED RUNON FROM UPLAND AREAS AND ROOFS OCCURS.
- ☐ HIGH RISK: 0 TO 1 PERCENT SLOPE OR UNEVEN TOPOGRAPHY THAT RESULTS IN POOLING OR CONCENTRATED FLOW OF RUNOFF WATER ON OR OFF THE SITE.

* NOTE ON USE. Sites receiving 'high risk' ratings for two or more individual criterion should receive more intensive investigation. Sites with four or more high risk criterion may not be suitable for AFO location.

Source: Adapted from Environment Technical Note Number MT-3 dated February 2006 by Tom Pick, Water Quality Specialist and Mike Garverich, Geotechnical Engineer.

Fertilizer Storage and Handling Worksheet

Ground and Surface Water Contaminants - Nutrients - Fertilizer Storage and Handling					
Farm:					
Rating Item	**Low Risk 4 Points**	**Low-Moderate Risk 3 Points**	**Mod-High Risk 2 Points**	**High Risk 1 Point**	**Score**
1. Amount stored	None stored at any time.	Less than 1 ton dry or 55 gallons liquid.	Between 1 and 20 tons dry or between 55 and 1,500 gallons liquid.	More than 20 tons dry or more than 1,500 gallons liquid.	
2. Type of storage	Dry formulations covered on impermeable surface and spills collected. Liquid formulations on impermeable surface where spill can be contained.	Dry formulations covered on clay soils, liquid formulations on clay lined secondary containment, most spill can be recovered.	Dry formulations partially covered on loamy soils, liquid formulations on loamy soils, most spill cannot be recovered.	No cover, dry and liquid formulations located on sandy soils, spills not recovered.	
3. Containers	Original containers clearly labeled and in good condition (no holes, tears, or weak seams). Lids tight.	Original containers in fair condition but with labels partially missing or hard to read.	Containers old showing signs of wear, high potential for leaks. Metal containers showing signs of rusting.	Containers with holes, tears, weak seams, fertilizer leaking, and no labels.	
4. Mixing and loading practices	Liquid formulations handled on concrete surface with curbs to contain and sump to collect leaks. Dry formulations handled on clayey soils with spills collected.	Liquid formulations handled on concrete surface with curbs to contain leaks and spills, no sump. Dry formulations handled on loamy soils most spills collected.	Liquid formulations handled on concrete pad with some cracks, no curbs or sump, some spill collected. Dry formulations handled on loamy soils most spills not collected.	Liquid formulations handled without a mixing/loading pad, permeable surface, spills soak into ground. Dry formulations handled on sandy soils spills not collected.	
5. Location of mixing and loading areas	Mixing and loading practices contain all spills and leaks. Located 100 or more feet down slope from well.	Located on permeable surface **50 to 100 feet of well** and over 500 feet from stream, pond, or drainageway.	Located on permeable surface between **10-50 feet of well** and within 100-500 feet from stream, pond, or drainageway.	Located on permeable surface within **10 feet of well** and within 100 feet from stream, pond or drainageway.	
6. Handling	Closed system for all liquid formulations. Dry product easily loaded. Very low risk of spill.	Some liquid formulation hand poured, easy to load both dry and liquid product, low risk of spill.	All liquids and dry products hand filled, fill port easy to reach, moderate risk of spill.	All liquids and dry products hand filled, fill port difficult to reach, high risk of spill.	
7. Cleanup and Disposal	Fertilizer sprayer or spreader washed out in the field. Rinsate (from liquid sprayer) collected and applied in next load on labeled crop.	Fertilizer sprayer or spreader washed on pad at farmstead. Rinsate (from liquid sprayer) collected and applied in next load on labeled crop.	Fertilizer sprayer or spreader washed at farmstead on permeable surface. Rinsate dumped at least 100 feet from well, stream or pond.	Fertilizer sprayer or spreader washed at farmstead on permeable surface. **Rinsate dumped at farmstead or in nearby field**.	
Nutrient Storage Rating		Accumulative Score (Sum of above rating items)			
		Average Score (Accumulative/7)			

Ratings: 3.6-4 = Low risk, 2.6-3.5 = Low to moderate risk, 1.6-2.5 = Moderate to high risk, 1-1.5 = High Risk

Boldface Type: Violates Montana Law.

Source: Modification of Montana Farm-A-Syst Worksheet #3, Fertilizer Storage and Handling

Nutrients, Organics and Pathogens - Livestock Manure Storage Worksheet (Pages 1 of 2)

Ground and Surface Water Contaminants - Nutrients, Organics and Pathogens - Livestock Manure Storage					
Farm:					
Rating Item	**Low Risk 4 Points**	**Low-Moderate Risk 3 Points**	**Mod-High Risk 2 Points**	**High Risk 1 Point**	**Score**
1. No on-farm storage facilities	Wastes hauled off farm for proper storage and disposal			Daily spreading of livestock wastes	
2a. On-farm (180 days or more) storage Steel, glass-lined (liquid-tight design, above ground) **OR** Concrete stave (liquid-tight design) **OR** Poured concrete (liquid-tight design) **OR** Earthen waste storage pit (below ground)	Designed and installed according to accepted engineering standards and specifications. Properly maintained. **OR** Designed and installed according to accepted engineering standards and specifications. Properly maintained. **OR** Designed and installed according to accepted engineering standards and specifications. Properly maintained. **OR** Designed and installed with a liner which meets all accepted engineering standards and specifications. Properly maintained.	Designed and installed according to accepted engineering standards and specifications. Not maintained. **OR** Designed and installed according to accepted engineering standards and specifications. Not maintained. **OR** Designed and installed according to accepted engineering standards and specifications. Not maintained. **OR** Designed and installed according to accepted engineering standards and specifications. Properly maintained.	Leaking tank on medium-textured soils (silt loam, loam). **OR** Concrete cracked, medium-textured soils (silt loam, loam). Water table deeper than 20 feet. **OR** Concrete cracked, medium-textured soils (silt loam, loam). Water table deeper than 20 feet. **OR** Not designed to engineering standards. Constructed in medium or fine-textured dense materials (silt loam, loam, clay loams, silty clay). Water table deeper than 20 feet. Earthen lining eroding.	Leaking tank on coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet. **OR** Concrete-cracked, coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet. **OR** Concrete cracked, coarse-textured soils (sands, sandy loam). Water table or fractured bedrock shallower than 20 feet. **OR** Not designed to engineering standards. Constructed in coarse-textured materials (sands, sandy loam). Fractured bedrock or water table shallower than 20 feet. More than 10 years old. Earthen lining perforated.	

Nutrients, Organics and Pathogens - Livestock Manure Storage Worksheet (Pages 2 of 2)

Ground and Surface Water Contaminants - Nutrients, Organics and Pathogens - Livestock Manure Storage					
Farm:					
Rating Item	**Low Risk 4 Points**	**Low-Moderate Risk 3 Points**	**Mod-High Risk 2 Points**	**High Risk 1 Point**	**Score**
2b On-farm (30-90 days; in some cases, up to 180 days) storage Stacked in field (on soil base) **OR** Stacked in yard **OR** Water-tight structure designed to accepted engineering standards and specifications **OR** Stacked in open housing	N/A **OR** Covered concrete yard with curbs, gutters and settling basin. **OR** Designed and installed according to accepted engineering standards. All liquids retained. **OR** Building has concrete floor, protected from surface water runoff. Adequate bedding provided.	Piled on level ground with a cover. **OR** Concrete yard with curbs and gutters. Grass filter strips installed and maintained. **OR** Designed and installed according to accepted engineering standards on medium- and fine-textured soils (silt loam, loam, clay loams, silty clay). Water table deeper than 20 feet. **OR** Building has earthen or concrete floor on medium- or fine-textured soils (silt loam, loam, clay loams, silty clay) protected from surface water runoff. Water table deeper than 20 feet.	Stacked on high ground. Medium-or fine-textured soils (silt loam, loam, clay loams, silty clay). Water table is deeper than 20 feet. **OR** Earthen yard with medium- or fine-textured soils (silt loam, loam, clay loams, silty clay). Water table is deeper than 20 feet. **OR** Designed and installed according to accepted engineering standards on coarse-textured soils (sands, sandy loams). Water table or fractured bedrock shallower than 20 feet **OR** Building has earthen or concrete floor on medium- or fine-textured soils (silt loam, loam, clay loams, silty clay) subject to surface water runoff. Water table deeper or fractured bedrock shallower than 20 feet.	Stacked on high ground. Coarse-textured soils (sands, sandy loam). Fractured bedrock or water table is shallower than 20 feet. **OR** Earthen yard with coarse-textured soils (sands, sandy loam). Fractured bedrock or water table shallower than 20 feet. **OR** Designed and installed according to accepted engineering standards. Not properly maintained. Water treatment and diversion and terrace structures allowed to deteriorate. **OR** Building has earthen floor on coarse-textured soils (sands, sandy loam) subject to surface water runoff. Water table or fractured bedrock shallower than 20 feet.	
3. Storage volume	Not full at end of rainy season; if liquid/slurry adequate capacity to hold 25-year, 24-hour storm; solids removed to avoid loss of storage capacity.	Not full at end of rainy season; if liquid/slurry not adequate capacity to hold 25-year, 24-hour storm.	Storage facility requires occasional emptying during the rainy season; if liquid/slurry not adequate capacity to hold 25-year, 24-hour storm.	Storage facility requires regular emptying during the rainy season; if liquid/slurry not adequate capacity to hold 25-year, 24-hour storm.	
4. Storage location	Manure stack or earthen waste storage pit more than 250 feet down slope from well. Manure storage structure (liquid tight) more than 100 feet down slope from well.	Manure stack or earthen waste storage pit more than 250 feet upslope from well. Manure storage structure (liquid tight) more than 100 feet upslope from well.	Manure stack or earthen waste storage pit less than 250 feet down slope from well. Manure storage structure (liquid tight) **less than 100 feet*** down slope from well.	Manure stack or earthen waste storage pit less than 250 feet upslope from well. Manure storage structure (liquid tight) **less than 100 feet*** upslope from well.	
Livestock Waste Storage Rating		Accumulative Score (Sum of above rating items)			
For Ground & Surface Waters		Average Score (Accumulative/ 4)			

Ratings: 3.6-4 = Low risk, 2.6-3.5 = Low to moderate risk, 1.6-2.5 = Moderate to high risk, 1-1.5 = High Risk

Boldface Type: Violates Montana Law.

*Illegal for new construction. Existing wells must meet separation distances in effect at time of construction.

Source: Modification of Montana Farm*A*Syst, Worksheet #7, Livestock Waste Storage

Nutrients, Organics and Pathogens - Livestock Yard Management Worksheet (Pages 1 of 2)

Ground and Surface Water Contaminants - Nutrients, Organics and Pathogens - Livestock Yard Management					
Farm:					
Rating Item	**Low Risk 4 Points**	**Low-Moderate Risk 3 Points**	**Mod-High Risk 2 Points**	**High Risk 1 Point**	**Score**
1. Location	More than 300 feet from well and more than 500 feet from stream, pond, or drainageway.	Between 200-300 feet of well and between 250-500 feet from stream, pond, or drainageway.	Between 100-200 feet of well and between 100-250 feet from stream, pond, or drainageway.	**Less than 100 feet** * of well and less than 100 feet from stream, pond, or drainageway.	
2. Livestock water source	Stock water in troughs, with overflow diverted to wastewater system.	Stock water in troughs with overflow diverted from lot area. Stock excluded from streams or ditches.	Live water fenced, with stock water provided in water gap.	Stock water provided by live stream or irrigation ditch.	
3. Surface water diversion	All upslope and roof water diverted. Diversion and gutters well maintained.	Most upslope surface and roof water diverted. Diversions and gutters occasionally maintained.	No surface water diverted. Some roof water collected and redirected. Gutters and diversions not maintained.	All water (surface and roof water) runs through the yard.	
4. Lot runoff control system	No yard runoff (either barn or roofed area).	All runoff collected from curbed lot. Solids separated. Water directed onto filter strip.	Most of lot runoff collected. Some solids removed. No filter strip.	Lot runoff uncontrolled.	
5. Yard cleaning and scraping	No yard (animals confined)	Once per week.	Once per month.	Rarely.	
6. Dairy cow concentration on yard	No yard. Confined to barn, or roofed yard.	75 sf/a or more on fenced, curbed concrete pad and/or 400 sf/a on graded earthen surface. More than 1800 sf/a in exercise area.	50 sf/a or more on concrete pad and/or 200-300 sf/a on earthen surface. More than 1200 sf/a in exercise area.	Some concrete, less than 50 sf/a and less than 100 sf/a on earthen surface.	
7. Dairy replacements concentration	No yard. Confined to barn or roofed yard.	More than 40 sf/a on fenced, curbed concrete pad and/or more than 150-200 sf/a on earthen yard.	More than 20 sf/a on concrete and/or 75 sf/a on earthen surface.	Less than 75 sf/a on earth.	
8. Beef feeder concentrations	No yard. Confined to barn with slotted floor.	Barn and/or paved lot more than 50 sf/a. Earthen lot with mound more than 300 sf/a, or without mound more than 500 sf/a.	No shelter. Paved lot with 40-50 sf/a. Earthen lot with mound more than 200 sf/a or earthen without mound more than 250 sf/a.	Paved less than 30 sf/a. Earthen less than 150 sf/a.	
9. Beef cows/heifers concentrations	Barn or roofed lot.	Barn with paved lot more than 60 sf/a. Earthen with mound 400 sf/a or without mound 600 sf/a.	Paved lot more than 30 sf/a. Earthen with mound 200-400 sf/a or without mound 300-600 sf/a.	Earthen without mound less than 200 sf/a.	
10. Sheep/ewes concentrations	No yard. Confined to barn or roofed yard.	Barn and paved lot more than 20 sf/a. Earthen more than 40 sf/a.	Barn and paved lot less than 15 sf/a. Earthen less than 25 sf/a.	Earthen less than 10 sf/a.	
11. Feeder lambs concentrations	No yard. Confined to barn.	Barn and paved lot more than 10 sf/a. Earthen more than 25 sf/a.	Barn and paved lot more than 5 sf/a. Earthen more than 10 sf/a.	Earthen less than 10 sf/a.	
12. Hogs/sows concentrations	No yard. Confined to barn.	Shed and paved lot more than 30 sf/a.	Shed and earthen lot more than 15 sf/a	Shed and earthen lot less than 10 sf/a.	
13. Horses concentrations	No yard. Confined to barn or pasture.	Earthen exercise lot more than 2,500 sf/a. No pasture.	Earthen exercise lot more than 1500 sf/a. No pasture.	Earthen exercise lot less than 1,000 sf/a. No pasture.	
14. Poultry concentrations Broilers Layers	No lot. In building with watering system in good working order. Runoff protected. No lot. In building with watering system in good working order. Runoff protected.	No lot. In building with watering system in good working order. Inadequate runoff protection. No lot. In building with watering system in good working order. Inadequate runoff protection.	Earthen lot of 2 sf/a or more, on medium-textured soils (silt loam, loam). Water table deeper than 20 feet. Earthen lot of 4 sf/a or more, on medium-textured soils (silt loam, loam). Water table deeper than 20 feet.	Earthen lot of less than 2 sf/a or more, on coarse-textured soils (sands, sandy loam). Water table shallower than 20 feet. Earthen lot of 4 sf/a or more, on coarse-textured soils (sands, sandy loam). Water table shallower than 20 feet.	

Nutrients, Organics and Pathogens - Livestock Yard Management Worksheet (Pages 2 of 2)

Ground and Surface Water Contaminants - Nutrients, Organics and Pathogens - Livestock Yard Management					
Farm:					
Rating Item	**Low Risk 4 Points**	**Low-Moderate Risk 3 Points**	**Mod-High Risk 2 Points**	**High Risk 1 Point**	**Score**
15. Turkeys	No lot. In building with watering system in good working order. Runoff. protected.	No lot. In building with watering system in good working order. Inadequate runoff protection.	Earthen lot of 8 sf/a or more, on medium-textured soils (silt loam, loam). Water table deeper than 20 feet.	Earthen lot of 4 sf/a or more, on coarse-textured soils (sands, sandy loam). Water table shallower than 20 feet.	
16. Ducks	No lot. In building with watering system in good working order. Runoff protected.	No lot. In building with watering system in good working order. Inadequate runoff protection.	Earthen lot of 4 sf/a or more, on medium-textured soils (silt loam, loam). Water table deeper than 20 feet.	Earthen lot of 4 sf/a or more, on coarse-textured soils (sands, sandy loam). Water table shallower than 20 feet.	
Livestock Yard Rating		Accumulative Score (Sum of above rating items)			
		Average Score (Accumulative/no. items rated)			

Ratings: 3.6-4 = Low risk, 2.6-3.6 = Low to moderate risk, 1.6-2.5 = Moderate to high risk, 1-1.5 = High Risk

Note: sf/a = square feet per animal

Boldface Type: Violates Montana Law.

*Illegal for new construction. Existing wells must meet separation distances in effect at time of construction.

Source: Modification of Montana Farm*A*Syst, Worksheet #8, Livestock Yards Management

Field Sheet 5A: Salinity – Page 1 of 1
Indicators for Receiving Watercourses and Water Bodies

Evaluator: _____ Date: _____
Water Body Evaluated: _____ Total Score: _____

(Circle one number among the four choices in each row which BEST describes the conditions of the field or area being evaluated. If a condition has characteristics of two categories, you can "split" a score.)

Rating Item	Excellent	Good	Fair	Poor
1. Geology of area and geochemistry of water	• Agricultural area overlies formations of igneous or metamorphic origin. • Few fractures or faults in the area. 10	• Agricultural area primarily overlies formations of igneous or metamorphic origin with occasional areas above marine deposits. • Few fractures or faults. • Low to moderate mineral content--soft waters. 7	• Agricultural area overlies marine deposits. • Faulting common. • Moderate to high mineral content--hard waters. 3	• Agricultural area overlies marine deposits of recent origin. • Fractures and faulting very common in the area. • High to very high mineral content. Soils of marine origin. Salty ground water and springs. Mineral springs. Saltwater intrusion. 0
2. Precipitation and irrigation requirements	• Average crop water consumption is equal to or less than average precipitation. • Minimal irrigation required. 8	• Average crop water consumption is between 5 and 10% more than average precipitation. • Moderate irrigation required. 6	• Average crop water consumption is between 10 and 25% more than precipitation. • Considerable irrigation required. 4	• Average crop water consumption exceeds average precipitation by more than 25%. • Maximal irrigation required. 0
3. Location of watercourse in watershed	• Near headwaters. 9	• Not far from headwaters. 7	• Moderate distance from headwaters. 5	• Far from headwaters. 3
4. Appearance of water's edge	• No evidence of salt crusts. 9	• Some evidence of white, crusty deposits on banks. 6	• Numerous localized patches of white, crusty deposits on banks. 4	• Most of the pond or stream bank covered with a thick, white, crusty deposit. Salt "feathering" on posts abundant. 1
5. Appearance of aquatic vegetation	• No evidence of wilting, toxicity, or stunting. 10	• Minimal wilting and toxicity, bleaching, leaf burn. • Little, if any, stunting. 7	• Stream or pond vegetation may show wilted and toxic symptoms-bleaching, leaf burn. • Presence of some salt-tolerant species. 3	• Evidence of severe wilting, toxicity, or stunting. • Presence of only the most salt-tolerant species or complete absence of vegetation. 0
6. Streamside vegetation	• Very few salt tolerant species. 8	• Few salt tolerant species. Refer to list below.* 7	• Increasing dominance of salt-tolerant species. 5	• Vegetation almost totally salt-tolerant species for absence of vegetation. 3
OPTIONAL 7. Animal teratology (birth defects and tumors in fish and other animals)	• No birth defects or tumors. 10	• Minimal birth defects and tumors occurring in the population randomly. 6	• Some birth defects and tumors. 1	• Considerable numbers of birth defects and tumors. 0
1. Add the circled Rating Item scores to get a total for the field sheet			TOTAL	
2. Circle the ranking for this site based on the total field score.				
RANKING	Excellent (47-64)	Good (32-46)	Fair (15-31)	Poor (14 or less)

*Salt-tolerant species include alkali sacaton, fourwing saltbush, saltgrass, tamarisk (salt cedar), galleta, western wheatgrass, crested wheat, reed canarygrass, and rabbitbrush.

Field Sheet 5B$_1$: Salinity Indicators – Pages 1 of 2
Flood or Furrow Irrigation Areas

Evaluator: _____ Date: _____
Farm/Field Evaluated: _____ Total Score: _____

(Circle one number among the four choices in each row which BEST describes the conditions of the field or area being evaluated. If a condition has characteristics of two categories, you can "split" a score.)

Rating Item	Excellent	Good	Fair	Poor
1. Length of off-farm delivery system from headgate to farm boundary	• Less than ¼ mile. 10	• Between ¼ and ½ mile. 7	• Between ½ and 1 mile. 3	• Greater than 1 mile. 0
2. Irrigation management practices including seepage potential of delivery system, overall irrigation rating, and timing of irrigation	• All canals lined or piped. • Excellent maintenance. • Clay soil texture. • Seepage rate of 0.1 to 1.0 cu. ft. of water per sq. ft. of surface per day (ft ^{3}/ ft. ^{2}/day). • Sediment ponds, fertilizer management, monitoring flow, and other BMPs used as needed. • Irrigation scheduling based on crop needs and testing by tensiometer, moisture block or neutron probe. 10	• Canals are partially lined. • Moderate maintenance. • Sandy clay soil texture. • Seepage rate of 0.2 to 1.1 ft ^{3}/ft ^{2}/day. • Most (80%) of needed practices installed. • Timing based on crop needs and maximum allowable deficiency (e.g., testing by wet ball or soil probe). 7	• Vegetated canals. • Little maintenance. • Sandy, silty, clay loams. • Seepage rate 0.3 to 1.3 ft^{3}/ft.^{2}/day. • About 50% of needed practices installed. • Irrigation tied to traditional irrigation scheduling with little regard to crops' water requirements. 3	• Earthen canals. • Maintenance leading to disturbed canal bottom. • Sands, loams, and silty loams. • Seepage rate 0.5 to 1.5 ft ft^{3}/ft.^{2}/day. • Poor management. Few needed practices installed. Continuing increase in number of evaporation ponds. • Excessive irrigation based on convenience and traditional irrigation scheduling. No consideration of crop needs. 0
3. Kind and properties of soils; permeability (adjusted Sodium Adsorption Ratio-SAR)	• Coarse-textured particles. Deep topsoil–excellent tilth. 9	• No restrictive properties–good tilth. 6	• Clay soils with high sodium and high salt. Reduced tilth. Several of the characteristics listed under poor. • Montmorilionite clay with SAR = 8. • Illite clay with SAR of 12-15. • Kaolinite clay with SAR of 20-23. 3	• High montmorillonite clays with high sodium and high salt. Black soils with dissolved organic matter. Poor tilth. Puddling, soggy soils, poor infiltration and drainage. Slick spots and white crust. • Montmorilionite clay with SAR 9. • Illite clay with SAR 16. • Kaolinite clay with SAR 24 0
4. Soil salinity (mmhos/cm) or (Decisiemans/ meter)	• Less than 0.8 (mmhos/cm). 9	• Between 0.8 and 1.5 (mmhos/cm). 6	• Between 1.5 and 2.5 (mmhos/cm). 3	• Greater than 2.5 (mmhos/cm). 0
5. Crop type productivity and appearance including specific ion toxicity (varies with species sensitivity to particular toxin)	• Crop type relatively non-tolerant to salt. Refer to Appendix. • High productivity. • Prolific growth. • None. 9	• Moderately salt-tolerant species predominate. • Average productivity-what's expected in the region. • Some wilting. 6	• Less salt-tolerant crops die out. Replacement by relatively salt-tolerant species. • Less than expected productivity. Some stunting. • Wilted and noticeable toxic symptoms-tip and marginal leaf burn, chlorosis (bleached areas), defoliation. Deep blue-green foliage. Thickened waxy coating on leaves. 3	• Only highly salt-tolerant crops can be grown. • Plants of variable size. Stunted growth. Reduced production. • Toxic symptoms and die off of crops sensitive to given ions. 1

Field Sheet 5B$_1$: Salinity Indicators – Pages 2 of 2

6. Animal productivity and health	• No reduction in productivity. • No incidence of disease. 9	• Minimal reduction in productivity. • Minimal incidence of disease. 6	• Some reduction in total growth, milk production, etc. • Moderate incidence of disease symptoms, such as diarrhea. 3	• Greatly reduced growth, milk production, etc. • With sudden salinity changes, livestock may reject water. • High incidence of disease symptoms such as diarrhea. 1
7. Potential for for ground water contamination	Low: • Soils rich to very rich in organic matter (>3.0%). • Slow to very slow percolation in heavy-textured soils such as clays, silty or sandy clays, or silty clay loams. • Perched water table present. • In protected bedrock areas (50 ft. of soil and shale cap), well depth is 75-100 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is greater than 150 ft. • In shallow bedrock areas (25-50 ft. soil and shale cap), well depth greater than 200 ft. • In Karst areas, well depth is greater than 1,000 ft. if aquifer is "confined." 9	Moderate: • Soils rich to moderate in organic matter (3.0 to 1.5%). • Slow to moderate percolation in clay loams or silts. • Perched water table present. • In protected bedrock areas, well depth is 30-74 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is 100-149 ft. • In shallow bedrock areas, well depth is 50-199 ft. • In Karst areas, well depth is 500-999 ft. . 6	Considerable: • Soils moderate to low in organic matter (1.5 to 0.5%). • Moderate to rapid percolation in silty loams, loams, or silts. • In protected bedrock areas, well depth is 15-29 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is 50-99 ft. • In shallow bedrock areas, well depth is 25-49 ft. • In Karst areas, well depth is 100-499 ft. 4	High: • Soils low to very low in organic matter (less than 0.5%). • Rapid percolation in coarse-textured loamy sands or sands. • In protected bedrock areas, well depth is less than 15 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is less than 50 ft. • In shallow bedrock areas, well depth is less than 25 ft. • In Karst areas, well depth is less than 100 ft. 0
1. Add the circled Rating Item scores to get a total for the field sheet			TOTAL	
2. Circle the ranking for this site based on the total field score.				
RANKING	Excellent (54-65)	Good (33-53)	Fair (12-32)	Poor (11 or less)

Field Sheet 1A: Sediment – Pages 1 of 2
Indicators for Receiving Watercourses and Water Bodies

Evaluator: _____ Date: _____
Water Body Evaluated: _____ Total Score: _____

(Circle one number among the four choices in each row which BEST describes the conditions of the field or water body being evaluated. If a condition has characteristics of two categories, you can "split" a score.)

Rating Item	Excellent	Good	Fair	Poor
1. Turbidity (best observed immediately following a storm event)	• What is expected under pristine conditions in your region. • Clear or very slightly muddy after storm event. • Objects visible at depths greater than 3 to 6 ft. (depending on water color). 9	• What is expected for properly managed agricultural land in your region. • A little muddy after storm event but clears rapidly. • Objects visible at depths between 1½ to 3 ft. (depending on water color). 7	• A considerable increase in turbidity for your region. • Considerable muddiness after a storm event. Stays slightly muddy most of the time. • Objects visible to depths of ½ to 1½ ft. (depending on water color). 3	• A significant increase in turbidity for your region. • Very muddy--sediment stays suspended most of the time. • Objects visible to depths less than ½ foot (depending on water color). 0
2. Bank stability in your viewing area	• Bank stabilized. • No bank sloughing. • Bank armored with vegetation, roots, brush, grass, etc. • No exposed tree roots. 10	• Some bank instability. • Occasional sloughing. • Bank well-vegetated. • Some exposed tree roots. 7	• Bank instability common. • Sloughing common. • Bank sparsely vegetated. • Many exposed tree roots and some fallen trees or missing fence corners, etc. • Channel cross-section becomes more V-shaped as opposed to U-shaped or widening. 4	• Significant bank instability. • Massive sloughing. • No vegetation on bank. • Many fallen trees, eroded culverts, downed fences, etc • Channel cross-section is V-shaped and stream course may be widening in non-cohesive soils. 1
3. Deposition (Circle a number in only A, B, C, or D) 3A. Rock or gravel streams **OR**	• Less than 10% burial of gravels, cobbles, and rocks. • Pools essentially sediment free. 9	• Between 10% and 25% burial of gravels, cobbles, and rocks. • Pools with light dusting of sediment. 7	• Between 25% and 50% burial of gravels, cobbles and rock. • Pools with a heavy coating of sediment. 3	• Greater than 50% burial of gravels, cobbles and rocks. • Few if any deep pools present. 1
3B. Sandy bottom streams **OR**	• Sand bars stable and completely vegetated. • No mudcaps or "drapes" (coverings of fine mud). • No mud plastering of banks; exposed parent material. • No deltas. 9	• Sand bars essentially stable and well, but not completely, vegetated. • Occasional mudcaps or "drapes." • Some mud plastering of banks. • Beginnings of delta formation. 7	• Sand bars unstable with sparse vegetation. • Mudcaps or "drapes" common. • Considerable mud plastering of banks. • Significant delta formation. 3	• Sand bars unstable and actively moving with no vegetation. • Extensive mudcaps or "drapes." • Extensive mud plastering of banks. • Extensive deltas. 1
3C. Mud-bottom streams **OR**	• Dark brown/black tannic-colored water (due to presence of lignins and tannins). • Abundant emergent-rooted aquatics or floating vegetation. 9	• Dark brown colored water 7	• Medium brown water, muddy bottom. 3	• Light brown colored, very muddy bottom. 1
3D. Ponds	• Ponds essentially sediment free. • No reduction in pond storage capacity. 9	• Ponds with light dusting of sediment. • Very little loss in pond storage capacity. 7	• Ponds with a heavy coating of sediment. • Some measurable loss in pond storage capacity. 3	• Ponds filled with sediment. • Significant reduction in pool storage capacity. 1

Field Sheet 1A: Sediment – Pages 2 of 2
Indicators for Receiving Watercourses and Water Bodies

4. Type and amount of aquatic vegetation and condition of periphyton (plants, growing on other plants, twigs, stones, etc.)	• Periphyton bright green to black. Robust. • Abundant emergent-rooted aquatics or shoreline vegetation. • In ponds, emergent-rooted aquatics (e.g., cattails, sedges, rushes) present, but in localized patches. 9	• Periphyton pale green and spindly. • Emergent-rooted aquatics or shoreline vegetation common. • In ponds, emergent-rooted aquatics common, but confined to well-defined band along shore. 7	• Periphyton very light colored or brownish and significantly dwarfed. • Sparse vegetation. • In ponds, emergent-rooted aquatics abundant in wide bank; encroachment of dry land species (grasses, etc.) along shore. 5	• No periphyton. • No vegetation. • In ponds, emergent-rooted aquatics predominant with heavy encroachment of dry land species. 2
OPTIONAL 5. Bottom stability of streams	• Stable. • Less than 5% of stream reach has evidence of scouring or silting. 9	• Slight fluctuation of streambed up or down (aggradation or degradation). • Between 5-30% of stream reach has evidence of scouring or silting. 7	• Considerable fluctuation of streambed up or down (aggradation or degradation). • Scoured or silted areas covering 30-50% of evaluated stream reach. • Flooding more common than usual. • More stream braiding than usual for region. 3	• Significant fluctuation of streambed up or down (aggradation or degradation). • More than 50% of stream reach affected by scouring or deposition. • Flooding very common. • Significantly more stream braiding than usual for region. 1
OPTIONAL: 6. Bottom dwelling aquatic organisms	• Intolerant species occur: mayflies, stoneflies, caddisflies, water penny, riffle beetle and a mix of tolerants. • High diversity. 9	• A mix of tolerants: shrimp, damselflies, dragonflies, black flies. • Intolerants rare. • Moderate diversity. 7	• Many tolerants (snails, shrimp, damselflies, dragon flies, black flies). • Mainly tolerants and some very tolerants. • Intolerants rare. • Reduced diversity with occasional upsurges of tolerants, e.g., tube worms and chironomids. 3	• Only tolerants or very tolerants: midges, craneflies, horseflies, rat-tailed maggots, or none at all. • Very reduced diversity; upsurges of very tolerants common. 1
1. Add the circled Rating Item scores to get a total for the field sheet			TOTAL	
2. Circle the ranking for this site based on the total field score.				
RANKING	Excellent (32-37)	Good (21-31)	Fair (9-20)	Poor (8 or less)
OPTIONAL RANKING (with #5 or #6)	Excellent (40-46)	Good (26-39)	Fair (11-25)	Poor (10 or less)
OPTIONAL RANKING (with #5 and #6)	Excellent (48-55)	Good (31-47)	Fair (13-30)	Poor (12 or less)

Field Sheet 1B: Sediment – Page 1 of 1
Indicators for Cropland, Hayland, or Pasture

Evaluator: _____ Date: _____
Farm/Field Evaluated: _____ Total Score: _____

(Circle one number among the four choices in each row which BEST describes the conditions of the field or area being evaluated. If a condition has characteristics of two categories, you can "split" a score.)

Rating Item	Excellent	Good	Fair	Poor
1. Erosion Potential	• Not significant. • Less than T (tolerance); little sheet, rill, or furrow erosion. • No gullies. 10	• Some erosion evident. • About T; some sheet, rill, or furrow erosion. • Very few gullies. 7	• Moderate erosion. • T to 2T. • Obvious gullies or furrows from heavy storm events. 3	• Heavy erosion. • More than 2T. • Many gullies, furrows or critical erosion areas. 0
2. Runoff Potential	Low: • Very flat to flat terrain (0-0.5% slope). • Runoff curve number (RCN) 61-70. • Rainfall (<8"). • Even, gentle (scattered shower-type) rainfall. 10	Moderate: • Flat to gently sloping (0.5-2.0% slope). • RCN 71-80. • Rainfall (8-15"). • Even, gentle to moderate intensity rainfall. 8	Considerable: • Gently to moderately sloping (2.0-5.0% slope). • RCN 8l-90. • Rainfall (16-22"). • Even to uneven intense rainfall. 4	High: • Moderately sloping to steep terrain (greater than 5%). • RCN greater than 90. • Rainfall (more than 22"). • Intense uneven rainfall, especially in seasons when soil is exposed. 0
3. Filtering effect sedimentation potential of a vegetated buffer or water/ sediment collecting basin.	• Intervening vegetation between cropland and watercourse > 200 ft. • Type of intervening vegetation un-grazed woodland, brush, or herbaceous plants. • Water and sediment control basins properly installed and maintained. 8	• Intervening vegetation between cropland and watercourse 100 to 200 ft. • Type of intervening vegetation grazed woodland, brush, or herbaceous plants or range. • Water and sediment control basins properly installed but poorly maintained. 6	• Intervening vegetation between cropland and watercourse 50 to 100 ft. • Type of intervening vegetation high density cropland. • Water and sediment control basins poorly installed and poorly maintained. 4	• Cropping from < 50 ft. up to water's edge. • Type of intervening vegetation low density cropland or bare soil. • No water and sediment control basins. 2
4. Resource Management Systems (RMS's) on whole farm (combined value for all areas)	• Excellent management. • RMS's always used as needed. 9	• Good management. • Most (80%) of the needed RMS's installed. 7	• Fair management. • About 50% of the needed RMS's installed. • Cropping confined to proper land class. 3	• Poor management. • Few, if any, needed RMS's installed. • Cropping not confined to proper classes. 0
5. Potential for ground water contamination	Low: • Soils rich to very rich in organic matter (> 3.0%). • Slow to very slow perco-lation in heavy-textured soils such as clays, silty or sandy clays, or silty clay loams. • Perched water table present. • In protected bedrock areas (50 ft. of soil and shale cap), well depth is 75-100 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is greater than 150 ft. • In shallow bedrock areas (25-50 ft. soil and shale cap), well depth greater than 200'. • In Karst areas, well depth is greater than 1,000 ft. if aquifer is "confined." 9	Moderate: • Soils rich to moderate in organic matter (3.0 to 1.5%). • Slow to moderate percolation in clay loams or silts. • Perched water table present. • In protected bedrock areas, well depth is 30-74 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is 100-149 ft. • In shallow bedrock areas, well depth is 50-199 ft. • In Karst areas, well depth is 500-999 ft. 6	Considerable: • Soils moderate to low in organic matter (1.5 to 0.5%). • Moderate to rapid percolation in silty loams, loams, or silts. • In protected bedrock areas, well depth is 15-29 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is 50-99 ft. • In shallow bedrock areas, well depth is 25-49 ft. • In Karst areas, well depth is 100-499 ft. 4	High: • Soils low to very low in organic matter (< 0.5%). • Rapid percolation in coarse-textured loamy sands or sands. • In protected bedrock areas, well depth is less than 15 ft. • In protected bedrock areas overlain with 50 ft. of sand or gravel, well depth is less than 50 ft. • In shallow bedrock areas, well depth is less than 25 ft. • In Karst areas, well depth is less than 100 ft. 0
1. Add the circled Rating Item scores to get a total for the field sheet			TOTAL	
2. Circle the ranking for this site based on the total field score.				
RANKING	Excellent (40-46)	Good (26-39)	Fair (10-25)	Poor (9 or less)

Stream Visual Assessment Protocol

Owners name _____ Evaluator's name _____ Date _____

Stream name _____ Waterbody ID number _____

Reach location _____

_____

Ecoregion _____ Drainage area _____ Gradient _____

Applicable reference site _____

Land use within drainage (%): row crop _____ hayland _____ grazing/pasture _____ forest _____ residential _____

confined animal feeding operations _____ Cons. Reserve _____ industrial _____ Other: _____

Weather conditions-today _____ Past 2-5 days _____

Active channel width _____ Dominant substrate: boulder _____ gravel _____ sand _____ silt _____ mud _____

Site Diagram

(NWCC Technical Note 99-1, Stream Visual Assessment Protocol, December 1998) 35

Assessment Scores

Channel condition	☐
Hydrologic alteration	☐
Riparian zone	☐
Bank stability	☐
Water appearance	☐
Nutrient enrichment	☐
Barriers to fish movement	☐
Instream fish cover	☐
Pools	☐
Invertebrate habitat	☐

Score only if applicable

Canopy cover	☐
Manure presence	☐
Salinity	☐
Riffle embeddedness	☐
Marcroinvertebrates Observed (optional)	☐

Overall score (Total divided by number scored)	_____	<6.0	**Poor**
		6.1-7.4	**Fair**
		7.5-8.9	**Good**
		>9.0	**Excellent**

Suspected causes of observed problems_____

_____

_____

_____

Recommendations_____

_____

_____

_____

_____

_____

_____

_____

_____

36 (NWCC Technical Note 99-1, Stream Visual Assessment Protocol, December 1998)

Petroleum Product Storage Worksheet – Pages 1 of 2

Ground and Surface Water Contaminants - Petroleum Storage					
Farm:					
Rating Item	**Low Risk 4 Points**	**Low-Moderate Risk 3 Points**	**Mod-High Risk 2 Points**	**High Risk 1 Point**	**Score**
LOCATION (all tanks)					
Position of tank in relation to drinking water well	Tank down slope more than 100 ft. from well in medium- or fine-textured soils (silt loam, loam, clay loams, silty clay) with low permeability.*	Tank at grade or upslope more than 100 ft. from well in medium- or fine-textured soils (silt loam, loam, clay loams, silty clay) with low permeability.*	Tank down slope more than 100 ft. from well in coarse-textured soil (sands, sandy loam) with high permeability.*	Tank at grade or upslope less than 100 ft. from private well, 200 ft. from public well in coarse-textured soil (sand, sandy loams) with high permeability.*	
Tank location and local land use (leakage potential)	Well-drained soils. Water table always beneath tank. Above-ground tank more than 50 ft. from buildings.	Moderately well-drained soils. Only occasionally high water table.	Located more than 50 ft. from buildings. Medium- or fine-textured soils (silt loams, loam, clay loams, silty clay) saturated seasonally.	Located near buildings and in area with fine-textured soils (clay loams, silty clay) often saturated.	
DESIGN AND INSTALLATION (all tanks)					
Type and age of tank/corrosion protection	Synthetic tank or tank protected from rust by cathodic protection.	Steel tank less than 15 years old, coated with paint or asphalt.	Coated steel tank 15 or more years old, OR bare steel tank less than 15 years old.	Bare steel tank 15 or more years old.	
Spill and tank overfill protection	Impermeable catch basin plus automatic shutoff.	Impermeable catch basin plus overfill alarm.	Impermeable catch basin or concrete catch pad.	No protection.	
Piping	Piping protected from rust by cathodic protection and isolated from tank, sloped back to tank. Check valve at pump (not at tank).	Piping galvanized but not isolated from tank. Pipe drains back to tank. Check valve at pump.	Pipe galvanized, not isolated or bare. Piping sloped back to tank, but check valve is located at tank (foot valve).	Piping and tank isolated and of dissimilar materials. Un-isolated pipe bare, cannot drain freely to the tank. All pressure pipe systems.	
Tank Installation	Installed by state-certified installer.	Installed according to recommendations provided with new tank by seller.	No information on installation.	Installed without backfill, setback, secondary containment, anchors and other protections, or by untrained individual.	
DESIGN AND INSTALLATION (aboveground tanks only)					
Tank Enclosure	Tank surrounded by 6-foot tall non-combustible building or fence with lock. Building well-ventilated. Fire-wall in place if setbacks do not conform to code.	Tank surrounded by low fence with lock. Fire wall in place if setbacks do not conform to code.	Tank surrounded by low fence. No lock. No firewall.	No enclosure.	

***Low permeability soils, like clay, allow water to flow through slowly. High permeability soils, like sand and gravel, allow much faster water movement.**

Petroleum Product Storage Worksheet (Page 2 of 2)

Ground and Surface Water Contaminants - Petroleum Storage					
Farm:					
Rating Item	**Low Risk 4 Points**	**Low-Moderate Risk 3 Points**	**Mod-High Risk 2 Points**	**High Risk 1 Point**	**Score**
Secondary containment	Tank placed within concrete or synthetic dike with pad able to hold 125% of tank capacity.	Tank placed within dike and pad made of low permeability soils, able to hold 125% of tank capacity.	Tank placed on pad.	No secondary containment.	
MONITORING (all tanks)					
Tank integrity testing and leak detection monitoring	Regular (monthly) leak monitoring.	Daily inventory control and annual tank tightness testing.	Occasional inventory control and annual tank tightness testing.	No inventory control, testing or monitoring.	
TANK CLOSURE (underground tanks)					
Unused tank	Tank taken from ground. Excavation checked for evidence of contamination.	Tank filled with inert material and excavation checked for evidence of leaking.	Tank removed or filled with inert material. Excavation not checked for contamination.	Tank left in ground	
Petroleum Product Storage Rating		Accumulative Score (Sum of above rating items)			
For Ground and Surface Waters		Average Score (Accumulative/4)			

Ratings: 3.6-4 = Low risk, 2.6-3.5 = Low to moderate risk, 1.6-2.5 = Moderate to high risk, 1-1.5 = High Risk
Source: Modification of Montana Farm*A*Syst, Worksheet #4, Petroleum Product Storage