Appendix H
Agricultural Practices

Agricultural Programs

Farmland Protection/Agricultural Districts Program (NYS)

One of the critical issues involved in land use planning decisions for agricultural uses is to ensure that agriculture protection deals primarily with the preservation of agriculture as an economic activity and not just as a use of open space. Traditionally, agricultural uses are part of large lot, low density, residential zoning districts. With increased residential development, however, conflicts between agricultural and residential uses have increased. Complaints about noise, odors, dust, chemicals, and slow-moving farm machinery may occupy enough of the resources of a farmer so as to have a negative impact on the viability of his or her farming activities.

Article 25-AA of the Agriculture and Markets Law is intended to conserve and protect agricultural land for agricultural production and as a valued natural and ecological resource. Under this statute, territory can be designated as an agricultural district. To be eligible for designation, an agricultural district must be certified by the county for participation in the State program. Once a district is designated, participating farmers within it can receive reduced property assessments and relief from local nuisance claims and certain forms of local regulation. Agricultural district designation under Article 25-AA does not generally prescribe land uses. Under section 305-a of Article 25-AA, municipalities are, however, restricted from adopting regulations applicable to farm operations in agricultural districts which unreasonably restrict or regulate farm structures or practices, unless such regulations are directly related to the public health or safety (Agriculture & Markets Law, §305-a(1); Town Law §283-a; Village Law §7-739). The law also requires municipalities to evaluate and consider the possible impacts of certain projects on the functioning of nearby farms. Projects that require "agricultural data statements" include certain land subdivisions, site plans, special use permits, and use variances. Farm operations within agricultural districts also enjoy a measure of protection from proposals by municipalities to construct infrastructure such as water and sewer systems, which are intended to serve non-farm structures. Under Agriculture and Markets Law, §305, the municipality must file a notice of intent with both the State and the county in advance of such construction. The notice must detail the plans and the potential impact of the plans on agricultural operations. If, on review at either the county or State levels, the Commissioner of Agriculture and Markets determines that there would be an unreasonable adverse impact, he or she may issue an order delaying construction, and may hold a public hearing on the issue. If construction eventually goes forward, the municipality must make adequate documented findings that all adverse impacts on agriculture will be mitigated to the maximum extent practicable. "Right-to-farm" is a term which has gained widespread recognition in the State's rural areas within the past several decades. Section 308 of the Agriculture and Markets Law grants protection from nuisance lawsuits to farm operators within agricultural districts or on land outside a district which is subject to an agricultural assessment under section 306 of the Law. The protection is granted to the operator for any farm activity which the Commissioner has determined to be a "sound agricultural practice." Locally, many rural municipalities have used their home rule power to adopt local "right-to-farm" laws. These local laws commonly grant particular land-use rights to farm owners and restrict activities on neighboring non-farm land which might interfere with agricultural practices.

Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program (EQIP) is a USDA-NRCS initiative authorized by the 1996 Farm Bill that provides farmers with technical, financial, and educational assistance to address soil, water, and natural resource concerns in an environmentally beneficial and cost-effective manner. A conservation plan is required to receive EQIP funding. EQIP addresses natural resource concerns through the implementation of structural, vegetative, and land use practices such as manure management facilities, abandoned well capping, tree planting, filter strips, nutrient, pest, and grazing management, and wildlife habitat protection and enhancement. Agricultural producers enter into five-to-ten year contracts with federal funding limited to $10,000 per year with a maximum of $50,000 for the total contract.

Additional Environmental Quality Incentives Program (EQIP) Information
<http://www.nhq.nrcs.usda.gov/PROGRAMS/COD/cit/eqipsmry.htm>

Agricultural Environmental Management (AEM)

Agricultural Environmental Management (AEM) is a program to assist farmers in identifying environmental issues on their farms and implementing measures to maintain their economic viability while simultaneously protecting natural resources. Farmers voluntarily enter into these partnerships and remain the primary decision-maker throughout the AEM process. The AEM program focuses on helping farmers comply with federal, state and local regulations relating to water quality and other environmental concerns. The NRCS and County Soil and Water Conservation Districts coordinate the program.

AEM is designed to provide a system for planning and implementing environmentally suitable farming practices through the following steps or tiers:

- Tier 1 – Farmers complete a survey that includes questions regarding current farm activities, future activities or plans, and areas of possible environmental concern. Where no concerns are identified, the AEM process ends and the farmer's good stewardship is documented.
- Tier 2 – Areas for environmental concern identified in the Tier 1 survey are further detailed through the completion of a corresponding worksheet. Technical assistance in completing the worksheet is often provided by a local agricultural agency. Through the worksheet, the need for a management plan is determined. If the related environmental concerns can be easily remedied the farmer's good stewardship is documented and the AEM process ends.
- Tier 3 – A plan to remedy the specific environmental concerns identified in Tiers 1 and 2 is developed and completed. The plan takes into account the economic concerns of the farmer as well as environmental concerns resulting from current agricultural processes. Existing waste management, nutrient management, and conservation plans may be included in the AEM plan.
- Tier 4 – The plan developed in Tier 3 is implemented through Best Management Practices (BMPs) to reduce nonpoint source pollution. Agricultural agency staff provide technical, educational, and (when available) financial assistance to farmers in implementing these BMPs.
- Tier 5 – On-going evaluation of the AEM program at the individual farm, county, watershed, and state level is conducted to insure that environmental concerns related to nonpoint source pollution and the economic viability of agriculture production are addressed.

Additional Agricultural Environmental Management (AEM) Information
http://www.agmkt.state.ny.us/soilwater/AEM.html

Animal Feeding Operations

Animal Feeding Operation (AFO) means a lot or facility (other than an aquatic animal production facility) where animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and the animal confinement areas do not sustain crops, vegetation, forage growth, or post-harvest residues in the normal growing season. Two or more animal feeding operations under common ownership are a single animal feeding operation if they physically adjoin each other, or if they use a common area or system for the disposal of wastes.

AFOs include Concentrated Animal Feeding Operations (CAFO). CAFOs are point sources of pollution under the National Pollution Discharge Elimination System (NPDES) and are regulated under Section 301 of the CWA. CAFO General Permit GP-99-01 is a single permit which covers all CAFOs (who apply for coverage) Statewide. Therefore, all CAFOs who are covered by General Permit GP-99-01 will have identical permit language and requirements. Unique facility-specific requirements will be detailed in the Agricultural Waste Management Plan, a requirement for all CAFOs.

For CAFO definitions and additional Animal Feeding Operation (AFO) Information
<http://www.epa.gov/owmitnet/afo.htm>

Conservation Reserve Enhancement Program (CREP)

The Conservation Reserve Enhancement Program (CREP) is a State-federal conservation partnership program targeted to address specific State and nationally significant water quality, soil erosion and wildlife habitat issues related to agricultural use. The program uses financial incentives to encourage farmers and ranchers to voluntarily enroll in contracts of 10 to 15 years in duration to remove lands from agricultural production. This community-based conservation program provides a flexible design of conservation practices and financial incentives to address environmental issues.

Additional Conservation Reserve Enhancement Program (CREP) Information
<http://www.fsa.usda.gov/dafp/cepd/crep/fact_sheet.htm>

Wildlife Habitat Incentives Program (WHIP)

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private lands. It provides both technical assistance and cost-share payments to help establish and improve fish and wildlife habitat. Participants who own or control land agree to prepare and implement a wildlife habitat development plan. The U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) offers participants technical and financial assistance for the establishment of wildlife habitat development practices. In addition, if the landowner agrees, cooperating State wildlife agencies and nonprofit or private organizations may provide expertise or additional funding to help complete a project.

Additional Wildlife Habitat Incentives Program (WHIP) Information
<http://www.nhq.nrcs.usda.gov/PROGRAMS/wwd/whipindex.htm>

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WASTE MANAGEMENT SYSTEM

New York

(number)

code NY312

DEFINITION

A planned system in which all necessary components are installed for properly managing liquid and solid waste, including runoff from concentrated waste areas.

PURPOSES

To manage waste in rural areas in a manner that prevents or minimizes degradation of air, soil, animal, plant and water resources and protects public health and safety. Such systems are planned to preclude excess discharge of pollutants to surface or ground water and to recycle waste through soil and plants to the fullest extent practicable.

CONDITION WHERE PRACTICE APPLIES

This practice applies where:

1. waste is generated by agricultural production or processing;
2. nutrient management is needed on waste from municipal and industrial treatment plants that are used in agricultural production;
3. all practice components necessary to make a complete system are specified;
4. soil, water, and plant resources are adequate to properly manage the waste,
5. the management on the farm is adequate to install, operate and maintain the practice components during adverse weather and under time constraints from other operations, and
6. this standard does not apply to pesticide, petroleum, or other hazardous waste.

CRITERIA

A waste management system for a given enterprise shall include the components necessary to properly manage waste. A system will consist of all necessary components that are needed to address all inventoried potential pollutants. Components shall not be installed until an overall waste management system plan is complete. Waste, as used in this standard includes both liquid and solid waste, waste water used in processing, and polluted runoff such as that from a barnyard or bunk silo.

Inventory: An inventory of the farm will be done to identify areas of potential pollutant sources or polluting sources that include by-products and wastes from feedlots, silos, animals, milking centers, and food processing facilities and lands receiving by-products and waste. See Waste Utilization (633).

The areas of potential concern identified by the inventory will be addressed with the specific watershed and the specific farm location in the watershed taken into account. This information may be obtained from the local county water quality committee or the local drinking water authority if the farm is within a public drinking water watershed or aquifer. Each farm will be evaluated for the specific risks to the watershed from biochemical oxygen demand (BOD), nutrients, odors, pathogens, and other potential pollutants that it could potentially release to the environment.

All livestock farms will also address Barnyard Water Management Systems (NY707).

All livestock farms without a Waste Storage Facility will include, as a minimum, Manure Pile Areas (NY749).

All farms with silage will address silage leachate control.

All farms with milking animals will address milking center waste control.

All farms where manure is spread on the land will include erosion control and surface water runoff control practices where needed.

Components: Design criteria for individual components shall be according to standards in the National Handbook of Conservation Practices. The criteria for the design of components not included in this handbook shall be consistent with sound engineering and agronomic principles. Components of complete waste management systems will include:

Nutrient Management (590)
Record Keeping (NY748)
Waste Utilization (633)

and may include, but not limited to, the following:

Access Road (560)
Barnyard Water Management Systems (NY707)
Compost Facility (317)
Critical Area Planting (342)
Dikes (356)
Diversions (362)
Farmstead or Feedlot Windbreak (380)
Fence (382)
Grass Filter Area (NY393A)
Grass Filter Strip (NY393S)
Grassed Waterways or Outlets (412)
Heavy Use Area Protection (561)
Irrigation Systems (441-442- 443)
Irrigation Water Conveyance (428-430)
Lined Waterway or Outlet (468)
Manure Pile Areas (NY749)
Manure Transfer (NY634)
Obstruction Removal (500)
Open Channel (582)
Pipeline (516)
Pond Sealing or Linings (521)
Roof Runoff Management System (NY558)
Sediment Basin (350)
Streambank or Shoreline Protection (580)
Subsurface Drain (606)
Surface Drainage (607) & 608)
Trough or Tank (614)
Underground Outlet (620)
Waste Storage Facilities (NY313)
Waste Treatment Lagoons (359)
Water and Sediment Control Basin (638)

Planning:

1. Waste shall be used to the fullest extent possible by recycling it through soil and plants. If the present cropping system is not sufficient for utilization of nutrients generated and imported on the farm, other alternatives will be used to prevent the nutrients from having an adverse effect on the environment. These alternatives may include such treatment practices as lagoons, wetland systems, and composting. Exporting the waste off site may be required. Other alternatives include source reduction, reducing the nutrients imported or produced on the farm; adding more land area to be cropped or that waste is spread on; or feed ration management. Alternatives should be evaluated as to the economic impact on the farm operation.

2. Clean water shall be excluded from concentrated waste areas to the fullest extent practical.

3. Waste shall be collected and spread on land, or treated and/or stored until it can be spread. Adequate storage must be provided to allow spreading during favorable weather and at times compatible with crop management and available labor. Allow extra storage capacity for wet weather conditions that prevent the normal land application of wastes. The amount of time, number of loads, and volume of the waste to be emptied from the storage will also be evaluated to determine if the time and labor required will be available when the storage is to be emptied.

4. The land that the waste is to be spread on shall be evaluated for its potential to produce runoff, leach to an aquifer, be flooded, and its proximity to watercourses. These hydrologically sensitive areas may change with the seasons.

5. The overall system shall include sufficient land for proper nutrient utilization or disposal of waste at locations, times, rates and volumes that maintain desirable water, soil, plant, and other environmental conditions.

6. Adequate erosion control and other soil and water management practices shall be incorporated to prevent system-related problems.

7. Polluted runoff and seepage from concentrated waste areas shall be intercepted and directed to storage or treatment facilities for future disposal or be directly applied to land in an acceptable manner.

8. Appropriate waste handling equipment for the collection, transport, and spreading of the waste shall be available or planned for effective operation of the system.

9. Odor management will be addressed. Management practices such as proper timing of application, evaluation of wind direction, location of facilities

and windbreaks, incorporation, anaerobic digestion, composting or other methods will need to be considered.

10. To conserve visual resources, vegetative screens and other methods should be planned, as appropriate, to improve visual conditions.
11. The waste management system will comply with federal, state, or local requirements, such as, EPA and DEC regulations for industrial waste, Concentrated Animal Feeding Operations (CAFO), Coastal Zone Management Reauthorization Act (CZMRA), or zoning regulations.
12. To protect animals and humans from drowning, dangerous gases, and other hazards; safety features and devices shall be included in planning waste management systems.

Sequence of Installation: The waste source with the highest potential for environmental damage should be treated first. The sequence of installation shall be planned so that all components are installed in a logical manner.

CONSIDERATIONS

Use existing inventories or previously prepared plans to avoid duplicated effort while insuring that the planning process is completed to meet the purpose of this plan.

PLANS AND SPECIFICATIONS

Plans for waste management systems shall be in keeping with the criteria contained within this standard. Plans and specifications for waste management system components shall be in keeping with the standards for the individual system components.

OPERATION AND MAINTENANCE

The owner or operator is responsible for operating and maintaining the system. Proper operation of a waste management system includes timing, scheduling and labor for collecting, storing, transporting, and distributing the waste and the component management practices.

REFERENCES

Listed below are publications helpful in planning this practice:

Agricultural Waste Management Field Handbook - Part 651, "National Engineering Handbook", USDA-NRCS, April 1992.

Guide to Agricultural Environmental Management in New York State, New York State Soil & Water Conservation Committee and New York State Department of Agriculture and Markets, Albany, NY, July 1997.

FARM-A-SYST; Farmstead Assessment System, University of Wisconsin-Extension, Agricultural Bulletin, Room 245, 30 N. Murray Street, Madison, WI 53715, July 1991.

Ontario Environmental Farm Plan, Ontario Farm Environmental Coalition, c/o Ontario Federation of Agriculture, 491 Eglinton Ave. W., Suite 500, Toronto, Ont. M5N 3A2, Canada, June 1993

Agricultural Management Practices Catalogue for Nonpoint Source Pollution Control and Water Quality Protection in New York State (Second Revision), NYS Department of Environmental Conservation, Division of Water, Albany, NY 12233, November 1992.

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NY312 Chronology

5/9/97 - Current revised standard.
10/20/97 - Component standard numbers changed to agree with revisions of other standards.
1/7/99 - Proposed revision as per recommendations of NY Nutrient Management Partnership.
1/8/99 - Endorsed by the NY Nutrient Management Partnership

Nutrient Loss from Agricultural Land Use

Phosphorus (P) and nitrogen (N) are the two major nutrients from agricultural land with the potential to degrade water quality. In the Cayuga Lake watershed, the various forms of fertilizers include:

- Commercial fertilizer in a dry or fluid form, containing nitrogen (N), phosphorus (P), potassium (K), secondary nutrients, and micronutrients;
- Manure from animal production facilities including bedding and other wastes added to the manure, containing N, P, K, secondary nutrients, micronutrients, salts, some metals, and organics;
- Municipal and industrial treatment plant sludge, containing N, P, K, secondary nutrients, micronutrients, salts, metals, and organic solids;
- Legumes and crop residues containing N, P, K, secondary nutrients, and micronutrients;
- Irrigation water (only limited use in this area); and
- Atmospheric deposition of nutrients such as nitrogen and sulfur.

Surface water runoff from agricultural lands to which nutrients have been applied may transport the following pollutants:

- Particulate-bound nutrients, chemicals, and metals, such as phosphorus, organic nitrogen, and metals applied with some organic wastes;
- Soluble nutrients and chemicals, such as nitrogen, phosphorus, metals, and many other major and minor nutrients;
- Sediment, particulate organic solids, and oxygen-demanding material;
- Salts; and
- Bacteria, viruses, and other microorganisms.

Ground-water infiltration from agricultural lands to which nutrients have been applied may transport soluble nutrients and chemicals, such as nitrogen, phosphorus, metals, and many other major and minor nutrients, and salts.

The nutrient of greatest concern in the Cayuga Lake watershed is phosphorus, the limiting nutrient for primary production in Cayuga Lake. The load and concentration of phosphorus ultimately determines the abundance, diversity, and types of plants and animals found in the lake ecosystem. Manure and fertilizers increase the level of available phosphorus in the soil to promote plant growth, but many soils now contain higher phosphorus levels than plants need (Killorn, 1980; Novais and Kamprath, 1978). Phosphorus can be found in the soil in dissolved, colloidal, or particulate forms.

A recent Cornell University study developed a nutrient mass-balance for several New York dairy farms. The study documented the excess of nutrients brought onto the farm as compared with nutrients leaving in products sold (Klausner 1995). Data from this report are summarized in Table H-1.

It is evident from the mass balance investigation that excess nutrients are generated on dairy farms, representing a potential for loss of N and P to water resources.

Runoff and erosion can carry some of the applied phosphorus to nearby water bodies. Dissolved inorganic phosphorus (soluble reactive phosphorus) is probably the only form directly available to algae. Particulate and organic phosphorus delivered to waterbodies may be released when the sediments are exposed to a chemically reduced (anaerobic) environment. Under current conditions, the dissolved oxygen concentrations in Cayuga Lake remain high at all depths and all seasons, so release of phosphorus adsorbed to sediments is low. However, particulate and organic phosphorus compounds are available to support rooted aquatic plant growth (macrophytes) that are present at nuisance levels in the lake's shallow northern and southern basins.

Table H-1	Nitrogen			Phosphorus		
Number of cows	45	85	120	45	85	120
Input (tons/yr)						
Purchased fertilizer	1.0	2.2	4.6	1.2	0.9	1.3
Purchased feed	3.8	9.7	21.4	1.0	0.7	5.3
Legume fixation	1.3	1.1	3.2	--	--	--
Total	6.1	13.0	29.2	2.2	2.6	6.7
Output (tons/yr)						
Milk	2.0	3.8	6.3	0.4	0.7	1.1
Meat	0.1	0.4	0.6	<0.1	0.1	0.2
Crops sold	0.1	0.5	--	<0.1	0.1	0.2
Total	2.2	4.7	6.9	0.4	0.8	1.3
Remainder	3.9	8.3	22.3	1.8	1.8	5.4
Remaining on farm	64%	64%	76%	81%	69%	81%

Excessive nitrogen may also cause or contribute to a number of other water quality problems. Dissolved ammonia at elevated concentrations may be toxic to fish, especially trout or early life stages of many species. Nitrates in drinking water are potentially dangerous, especially to infants. The U.S. Environmental Protection Agency has set a limit of 10 mg/L nitrate-nitrogen in water used for human consumption (USEPA, 1989).

Nitrogen is naturally present in soils but must be added to increase crop production. Nitrogen is added to the soil primarily by applying commercial fertilizers and manure, but also by growing legumes (biological nitrogen fixation) and incorporating crop residues. Not all nitrogen that is present in or on the soil is available for plant use at any one time. Organic nitrogen normally constitutes the majority of the soil nitrogen. It is slowly converted (2 to 3 percent per year) to the more readily plant-available inorganic ammonium or nitrate.

The chemical form of nitrogen affects its impact on water quality. The most biologically important inorganic forms of nitrogen are ammonium (NH4-N), nitrate (NO3-N), and nitrite (NO2-N). Organic nitrogen occurs as particulate matter, in living organisms, and as detritus. It occurs in dissolved form in compounds such as amino acids, amines, purines, and urea.

Nitrate-nitrogen is highly mobile and can move readily below the crop root zone, especially in sandy soils. It can also be transported with surface runoff, but not usually in large quantities. Ammonium, on the other hand, becomes adsorbed to the soil and is lost primarily with eroding sediment. Even if nitrogen is not in a readily available form as it leaves the field, it can be converted to an available form either during transport or after delivery to waterbodies.

Monitoring data from the watershed indicates a significant range in nitrate concentration in streams draining the Cayuga watershed. Land use appears to be important; streams draining agricultural subwatersheds have higher concentrations of nitrate than streams in more forested areas. An interesting annual pattern is evident in the stream data. Higher concentrations are present in the winter, when there is little nutrient uptake by the vegetation.

Methods to Control Nutrient Loss

According to EPA (1996) the best management practices to control nutrient loss begin with a detailed site-specific plan relating the amount of nutrients applied to field conditions and needs of the crops. "Develop, implement, and periodically update a nutrient management plan to: (1) apply nutrients at rates necessary to achieve realistic crop yields, (2) improve the timing of nutrient application, and (3) use agronomic crop production technology to increase nutrient use efficiency. When the source of the nutrients is other than commercial fertilizer, determine the nutrient value and the rate of availability of the nutrients. Determine and credit the nitrogen contribution of any legume crop. Soil and plant tissue testing should be used routinely."

This commonly recommended management measure would reduce the potential for nutrient loss to both groundwater and surface waters. Another benefit is economic: most farms would reduce the amount of nutrients applied on a given site. Many producers in the Cayuga Lake watershed are already using systems that satisfy or partly satisfy the intent of this management measure, the only action that may be necessary is to determine the effectiveness of the existing practices and add additional practices. In the Cayuga Lake watershed, these voluntary measures can be implemented on individual farms as part of the whole farm planning process referenced above.

Specific data and information that may be important in refining a nutrient management plan include (EPA 1993):

1. Detailed soil surveys (these will help define nutrient status of soils and highlight environmentally sensitive locations).
2. Use of producer-documented yield history and other relevant information to determine realistic crop yield expectations. Appropriate methods include averaging the three highest yields in five consecutive crop years for the planning site, or other

methods based on Cornell Cooperative Extension publications. Increased yields due to the use of new and improved varieties and hybrids should be considered when yield goals are set for a specific site.

3. Results of soil testing for pH and major nutrients (N, P, K).
4. Plant tissue analysis.
5. Nutrient analysis of manure or other residuals applied to the soil.
6. Use of proper timing, formulation, and application methods for nutrients that maximize plant utilization of nutrients and minimize the loss to the environment, including split applications and banding of the nutrients, use of nitrification inhibitors and slow-release fertilizers, and incorporation or injection of fertilizers, manures, and other organic sources.
7. Use of small grain cover crops to scavenge nutrients remaining in the soil after harvest of the principal crop, particularly on highly leachable soils. Consideration should be given to establishing a cover crop on land receiving sludge or animal waste if there is a high leaching potential. Sludge and animal waste should be incorporated.
8. Use of buffer areas or intensive nutrient management practices to limit application of fertilizers in environmentally high risk areas such as:

- Karstic areas containing sinkholes and shallow soils over fractured bedrock (for example, in the Yawger and Canoga Creek subwatersheds)
- Riparian zones;
- Highly erodible soils;
- Shallow aquifers.

9. Control phosphorus losses from fields by using BMPs aimed at controlling both erosion and nutrient losses. Calculate the upper limit on application rates of manure and sludge based on the phosphorus needs of the crop, supplying any additional nitrogen needs with nitrogen fertilizers or legumes. If this is not practical, apply excess phosphorus to fields that will be rotated into legumes, to other fields that will not receive manure applications the following year, or to sites with low runoff and low soil erosion potential.

Animal Wastes

There are very little data to evaluate the extent to which animal wastes are a significant nonpoint source of pollution in the Cayuga watershed. Animal waste (manure) includes the fecal and urinary wastes of livestock and poultry; process water (such as from a milking parlor); and the feed, bedding, litter, and soil with which they become intermixed. The following pollutants may be contained in manure and associated bedding materials and could be transported by runoff water and process wastewater from confined animal facilities:

- Oxygen-demanding substances;
- Nitrogen, phosphorus, and many other major and minor nutrients or other deleterious materials;
- Organic solids;
- Salts;
- Bacteria, viruses, and other microorganisms; and
- Sediments.

Fish kills may result from runoff, wastewater, or manure entering surface waters, due to ammonia or dissolved oxygen depletion. The decomposition of organic materials can deplete dissolved oxygen supplies in water, resulting in anoxic or anaerobic conditions.

Solids deposited in waterbodies can accelerate eutrophication through the release of nutrients over extended periods of time. Because of the high nutrient and salt content of manure and runoff from manure-covered areas, contamination of ground water can be a problem if storage structures are not built to minimize seepage.

Animal diseases can be transmitted to humans through contact with animal feces. Runoff from fields receiving manure will contain extremely high numbers of bacteria if the manure has not been incorporated or the bacteria have not been subject to stress. Beach closure can result from high fecal coliform counts.

The method, timing, and rate of manure application are significant factors in determining the likelihood that water quality contamination will result. Manure is generally more likely to be transported in runoff when applied to the soil surface than when incorporated into the soil. Spreading manure on frozen ground or snow can result in high concentrations of nutrients being transported from the field during rainfall or snowmelt, especially when the snowmelt or rainfall events occur soon after spreading (Robillard and Walter, 1986).

When application rates of manure for crop production are based on crop N needs, the P and K rates normally exceed plant requirements (Westerman et al., 1985). The soil generally has the capacity to adsorb phosphorus leached from manure applied on land. As previously noted, however, nitrates are easily leached through soil into groundwater or to return flows, and phosphorus can be transported by eroded soil.

Management and structural improvements to young stock raising and manure handling facilities may be required to reduce the risk that pathogenic protozoa (Cryptosporidia and Giardia) might reach surface waters. According to NYSDEC, the first barrier for reducing pathogen risk from farming activities is proper calf and heifer management. Maintaining healthy calves may minimize the occurrence of pathogens on farms. Additional practices to reduce contamination with these pathogens include: preventing runoff from animal housing and exercise areas, handling manure from young stock separately, treating or storing manure, and carefully selecting land application areas to avoid hydrologically sensitive areas.

Conditions that cause a rapid die-off of bacteria are low soil moisture, low pH, high temperatures, and direct solar radiation. Manure storage generally promotes die-off, although pathogens can remain dormant at certain temperatures. Composting the wastes can be quite effective in decreasing the number of pathogens.

Methods to Control Nonpoint Source Pollution from Animal Wastes

USDA and EPA have collaborated on a series of BMPs for manure handling. The following guidance is adapted from the March 1999 joint publication "Unified National Strategy for Animal Feeding Operations".

Manure needs to be handled and stored properly to prevent water pollution from animal feeding operations (AFOs). Manure and wastewater handling and storage practices should also consider odor and other environmental and public health problems. Handling and storage considerations should include:

- Divert clean water - Siting and management practices should divert clean water from contact with feedlots and holding pens, animal manure, or manure storage systems. Clean water can include rainfall falling on roofs of facilities, runoff from adjacent lands, or other sources.
- Prevent leakage - Construction and maintenance of buildings, collection systems, conveyance systems, and permanent and temporary storage facilities should prevent leakage of organic matter, nutrients, and pathogens to ground or surface water.
- Provide adequate storage - Liquid manure storage systems should safely store the quantity and contents of animal manure and wastewater produced, contaminated runoff from the facility, and rainfall. Dry manure, such as that produced in certain poultry and beef operations, should be stored in production buildings or storage facilities, or otherwise stored in such a way so as to prevent polluted runoff. Location of manure storage systems should consider proximity to water bodies, floodplains, and other environmentally sensitive areas.
- Manure treatments - Manure should be handled and treated to reduce the loss of nutrients to the atmosphere during storage, to make the material a more stable fertilizer when land-applied or to reduce pathogens, vector attraction and odors, as appropriate.
- Management of dead animals - Dead animals should be disposed of in a way that does not adversely affect ground or surface water or create public health concerns. Composting, rendering, and other practices are common methods used to dispose of dead animals.

Sediment Loss from Agricultural Land Use

Sediment has been identified as a significant water quality issue in the Cayuga Lake watershed. Both measurement and observation confirm that visible plumes of sediment flow into the lake from its southern tributaries during storms and snowmelt. Sediment can adversely affect the quality of streams and lakes and diminish their suitability as habitat for plants and animals. Suspended sediment can reduce the amount of sunlight available to aquatic plants, cover fish spawning areas and food supplies, interfere with filter feeding organisms, and clog and harm the gills of fish. Turbidity interferes with the feeding habits of fish. These effects combine to reduce fish and plant populations and decrease the overall productivity of the aquatic resource. In addition, recreation is limited because of the decreased fish population and the water's unappealing, turbid appearance. Turbidity also reduces visibility, making swimming less safe.

According to EPA "Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters" chemicals such as some pesticides, phosphorus, and ammonium are transported with sediment in an adsorbed state. Changes in the aquatic environment, such as a lower concentration in the overlying waters or the development of anaerobic conditions in the bottom sediments, can cause these chemicals to be released from the sediment. Adsorbed phosphorus transported by the sediment may not be immediately available for phytoplankton growth but does serve as a long-term contributor to eutrophication. This adsorbed phosphorus may be immediately available to the macrophyte community.

Sediment from agricultural lands is the solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice. The types of erosion associated with agriculture that produce sediment are (1) sheet and rill erosion and (2) gully erosion. Soil erosion can be characterized as the transport of particles that are detached by rainfall, flowing water, or wind. Eroded soil is either redeposited on the same field or transported from the field in runoff.

Sediments from different sources vary in the kinds and amounts of pollutants that are adsorbed to the particles. For example, sheet and rill erosion mainly move soil particles from the surface or plow layer of the soil. Sediment that originates from surface soil has a higher pollution potential than that from subsurface soils. The topsoil of a field is usually richer in nutrients and other chemicals because of past fertilizer and pesticide applications, as well as nutrient cycling and biological activity. Topsoil is also more likely to have a greater percentage of organic matter. Sediment from gullies and streambanks usually carries less adsorbed pollutants than sediment from surface soils.

Soil eroded and delivered from cropland as sediment usually contains a higher percentage of finer and less dense particles than the parent soil on the cropland. This change in composition of eroded soil is due to the selective nature of the erosion process. For example, larger particles are more readily detached from the soil surface because they are less cohesive, but they also settle out of suspension more quickly because of their size. Organic matter is not easily detached because of its cohesive properties, but once detached it is easily transported because of its low density. Clay particles and organic residues will remain suspended for longer periods and at slower flow velocities than will larger or denser particles. This selective erosion can increase overall pollutant delivery per ton of sediment delivered because small particles have a much greater adsorption capacity than larger particles. As a result, eroding sediments generally contain higher concentrations of phosphorus, nitrogen, and pesticides than the parent soil (i.e., they are enriched).

Methods to Control Erosion and Sedimentation

The objective of this class of best management practices (BMPs) is to reduce the mass load of sediment reaching a waterbody. Two different strategies can be used. The first, and most desirable, strategy is to implement practices on the field to prevent erosion and sediment transport. Practices that could be used to accomplish this include conservation tillage, contour strip-cropping, terraces, and critical area planting.

The second strategy is to route runoff from fields through BMPs that remove sediment. Practices that could be used to accomplish this include filter strips, field borders, grade stabilization structures, sediment retention ponds, water and sediment control basins, and terraces. Site conditions will dictate the appropriate combination of practices for any given situation.

Site-specific solutions may be developed for farms through participation in whole farm planning in cooperation with technical staff from County Soil and Water Conservation Districts, NRCS, Cornell Cooperative Extension, Farm Services Agency etc. Education and outreach are an important component of this effort.

Measures to reduce sediment loss have the potential to increase movement of water and soluble pollutants through the soil profile to the ground water. Erosion and sediment control systems must be carefully designed to protect against the contamination of ground water. Ground-water protection will also be provided through implementation of the nutrient and pesticide management measures to reduce and control the application of nutrients and pesticides.

To ensure that the selected BMPs continue to function as designed and installed, some operational functions and maintenance will be necessary over the life of the practices. Since BMPs will be designed to control a specific storm frequency, they may suffer damage when larger storms occur. Damage must be repaired after such storms and practices must be inspected periodically.

Pesticides

EPA defines a pesticide as a substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest or intended for use as a plant regulator, defoliant, or desiccant. Pesticides may target many organisms, among them insects, fungi, certain weeds, mites, or nematode worms. In recent years, USGS and the NYSDEC have monitored selected tributaries and Cayuga Lake for pesticides using analytical testing methods that can detect these compounds at very low concentrations. Results indicate that measurable concentrations of pesticides and their breakdown products (metabolites) have been detected in both the streams and the lake. The concentration of no individual chemical in the lake water exceeds its associated water quality standard designed to protect human health and the environment. However, toxicological data on the effects of pesticide metabolites and mixtures of chemicals are limited. The chemicals detected in Cayuga Lake and its tributaries in highest concentrations are herbicides used to control weeds in corn and soybean production. Residential land uses may also be a source.

Pesticides and their metabolites may enter ground and surface water in solution, in emulsion, or bound to soil colloids and may impair water for its designated uses. Some types of pesticides are resistant to degradation and may persist and accumulate in aquatic ecosystems. Pesticides may harm the environment by eliminating or reducing populations of desirable organisms, including endangered species. Sublethal effects include the behavioral and structural changes of an organism that jeopardize its survival. For example, certain pesticides have been found to inhibit bone development in young fish or to affect reproductive success.

Herbicides in the aquatic environment can destroy the food source for higher organisms, or reduce the amount of vegetation available for habitat and stabilization of soft sediments. Also, the decay of plant matter exposed to herbicide-containing water can cause reductions in dissolved oxygen concentration (North Carolina State University, 1984).

A major source of contamination from pesticide use is a result of their normal application. Other sources of pesticide contamination are atmospheric deposition, spray drift during the application process, misuse, and spills, leaks, and discharges that may be associated with pesticide storage, handling, and waste disposal.

The primary routes of pesticide transport to aquatic systems are (Maas et al., 1984):
1. Direct application;
2. In runoff;
3. Aerial drift;
4. Volatilization and subsequent atmospheric deposition; and
5. Uptake by biota and subsequent movement in the food web.

The amount of field-applied pesticide that leaves a field in the runoff and enters a stream primarily depends on:
1. The intensity and duration of rainfall or irrigation;
2. The length of time between pesticide application and rainfall occurrence;
3. The amount of pesticide applied and its soil/water partition coefficient;
4. The length and degree of slope and soil composition;
5. The extent of exposure to bare (vs. residue or crop-covered) soil;
6. Proximity to streams;
7. The method of application; and
8. The extent to which runoff and erosion are controlled with agronomic and structural practices.

This variability in the actual loss of field-applied material presents challenges for a monitoring program designed to estimate the magnitude and significance of pesticide loss from agricultural fields in the Cayuga Lake watershed. An intensive monitoring of three subwatersheds in the summer of 1998 for two pesticides indicated highly variable concentrations both temporally (over the course of the storm) and spatially (between the subwatersheds with different soils, geology, and agricultural practices). (Eckhardt et al 1999).

Pesticide losses are generally greatest when rainfall is intense and occurs shortly after pesticide application, a condition for which water runoff and erosion losses are also greatest. Pesticides can be transported to receiving waters either in dissolved form or attached to sediment. Dissolved pesticides may be leached to ground-water supplies. The rate of pesticide movement through the soil profile to ground water is inversely proportional to a chemical-specific adsorption partition coefficient Kd (a measure of the degree to which a pesticide is partitioned between the soil and water phase). The higher the value of Kd, the less tendency the chemical will have to move with water. Both the degradation and adsorption characteristics of pesticides are highly variable.

Methods to Control Pesticide Loss

The most effective approach to reducing pesticide pollution of waters is, first, to release fewer pesticides and/or less toxic pesticides into the environment and, second, to use practices that minimize the movement of pesticides to surface water and ground water (EPA 1993).

The pesticide management measures identify a series of steps or thought processes that producers should use in managing pesticides. A careful field-specific review of pest problems, previous pest control measures, and cropping history must be conducted. Each area targeted for application should review soil and hydrologic conditions to estimate the potential for off-site migration to groundwater or surface water. Integrated pest management (IPM) strategies should be used to minimize the amount of pesticides applied. Pesticides should be applied efficiently and at times when precipitation or high winds are unlikely. Storage, mixing and disposal of pesticides and containers must consider the potential for losses to groundwater and surface waters. Equipment should be tested and calibrated prior to use.

EPA has compiled a list of BMPs for pesticides, illustrating the types of practices that can be applied successfully to minimize this important aspect of agricultural nonpoint source pollution (EPA 1993). The EPA list is summarized below.

(1) Inventory current and historical pest problems, cropping patterns, and use of pesticides for each field.

This can be accomplished by using a farm and field map, and by compiling the following information for each field:

- Crops to be grown and a history of crop production;
- Soil types;
- The exact number of acres within each field; and
- Records on past pest problems, pesticide use, and other information for each field.

(2) Consider the soil and physical characteristics of the site including mixing, loading and storage areas for potential for the leaching and/or runoff of pesticides.

In situations where the potential for loss is high, emphasis should be given to practices and/or management practices that will minimize these potential losses. The physical characteristics to be considered should include limitations based on environmental hazards or concerns such as:

- Sinkholes, wells, and other areas of direct access to ground water such as karstic topography;
- Riparian areas
- Runoff potential;
- Wind erosion and prevailing wind direction;
- Highly erodible soils;
- Soils with poor adsorptive capacity;
- Highly permeable soils;
- Shallow aquifers; and
- Wellhead protection areas.

(3) Use IPM strategies to minimize the amount of pesticides applied.

Following is a list of IPM strategies:
- Use of biological controls:
- introduction and fostering of natural enemies;
- preservation of predator habitats; and
- release of sterilized male insects;
- Use of pheromones:
- for monitoring populations;
- for mass trapping;
- for disrupting mating or other behaviors of pests; and
- to attract predators/parasites;
- Use of crop rotations to reduce pest problems;
- Use of improved tillage practices such as ridge tillage;
- Use of cover crops in the system to promote water use and reduce deep percolation of water that contributes to leaching of pesticides into ground water;
- Destruction of pest breeding, refuge, and over wintering sites (this may result in loss of crop residue cover and an increased potential for erosion)
- Use of mechanical destruction of weed seed;
- Habitat diversification;
- Use of allelopathy characteristics of crops;
- Use of resistant crop strains;
- Pesticide application based on economic thresholds, i.e., apply pesticides when an economic threshold level has been reached as opposed to applying pesticides in anticipation of pest problems;
- Use of periodic scouting to determine when pest problems reach the economic threshold on each field;
- Use of less environmentally persistent, toxic, and/or mobile pesticides;
- Use of timing of field operations (planting, cultivating, irrigation, and harvesting) to minimize application and/or runoff of pesticides; and
- Use of more efficient application methods, e.g., spot spraying and banding of pesticides.

(4) When pesticide applications are necessary and a choice of materials exists, consider the persistence, toxicity, and runoff and leaching potential of products along with other factors, including current label requirements, in making a selection.

> Users must apply pesticides in accordance with the instructions on the label of each pesticide product and must be trained and certified in the proper use of the pesticide. Labels include a number of requirements including allowable use rates; classification of pesticides as "restricted use" for application only by certified applicators; safe handling, storage, and disposal requirements; and any restrictions needed to protect ground water; and other requirements.

(5) Maintain records of application of restricted use pesticides (product name, amount, approximate date of application, and location of application of each such pesticide used) for a 2-year period after such use, pursuant to the requirements of the 1996 Farm Bill.

(6) Use lower pesticide application rates than those called for by the label when the pest problem can be adequately controlled using such lower rates.

(7) Consider the use of organic farming techniques that do not rely on the use of synthetically compounded pesticides.

(8) Recalibrate spray equipment each spray season and use anti-backflow devices on hoses used for filling tank mixtures.

> Purchase new, more precise application equipment and other related farm equipment (including improved nozzles, computer sensing to control flow rates, radar speed determination, electrostatic applicators, and precision equipment for banding and cultivating), as replacement equipment is needed.

(9) Integrated crop management system: A total crop management system that promotes the efficient use of pesticide and nutrients in an environmentally sound and economically efficient manner.