BEST MANAGEMENT PRACTICES FOR MOSQUITO CONTROL AND FRESHWATER WETLANDS MANAGEMENT

State Mosquito Control Commission
c/o N.J. Dept. of Environmental Protection
P.O. Box 400
Trenton, N.J. 08625-0400

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AND

FRESHWATER WETLANDS MANAGEMENT

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PREPARED BY

OFFICE OF MOSQUITO CONTROL COORDINATION

PO BOX 400

TRENTON, NJ 08625-0400

REVISED

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Jon S. Corzine
Governor

Lisa P. Jackson
Acting Commissioner

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
MANUAL ON
BEST MANAGEMENT PRACTICES FOR MOSQUITO CONTROL
AND FRESHWATER WETLANDS MANAGEMENT

A Manual of Freshwater Wetland Management Practices
for Mosquito Control in New Jersey

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New Jersey Department of Environmental Protection's
Office of Mosquito Control Coordination
Green Acres program
Land use Regulation
Division of Fish and Wildlife
Division of Parks and Forestry

U.S. Fish and Wildlife Service
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S.D.A. Natural Resources Conservation Service

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INTRODUCTION

Although wetland values have been recognized for many years, efforts to preserve freshwater wetlands through regulation are relatively recent. Public agencies such as the US Environmental Protection Agency are actively engaged in wetland research of a basic and applied nature. Various organizations are also actively engaged in the training of wetland managers through numerous publications and seminars.

Both the US Environmental Protection Agency and the New Jersey Department of Environmental Protection have identified urban quality stormwater runoff as a major pollutant which often contains high concentrations of toxic materials. Large volumes of this pollutant are regularly flushed from developed areas into wetlands throughout much of the State. Sedimentation from both agricultural and construction activities has also been a major source of degradation of freshwater wetlands, particularly those situated within stream corridors.

The New Jersey Department of Environmental Protection, has concluded that stormwater runoff is a significant contributor to degradation of ground and surface waters and to the violation of water quality standards. Pollution in stormwater runoff from urban and urbanizing areas is a major environmental problem. It is reasonable to conclude that repeated recharge of freshwater wetlands by urban type stormwater runoff will have a significant and cumulative adverse impact upon that wetland environment. These destructive impacts include the loss of natural mosquito predators, and fluctuating wetland water levels. These conditions often create mosquito producing habitat which may be in close proximity to residential areas. The preservation of healthy freshwater wetlands, unpolluted by excessive urban stormwater runoff and/or sedimentation is, therefore, of vital concern to mosquito control agencies throughout the State.

Altered Wetland Hydrology

As upland areas adjacent to freshwater wetlands are developed, the natural hydrology of the wetlands is usually disturbed. First, existing ground infiltration is reduced by the construction of impermeable surfaces such as sidewalks, parking lots and streets. Secondly the radically increased surface runoff is released into a stormwater facility, or nearby wetland areas and streams. Consequently, there are predictable and pronounced impacts upon the wetland's hydrologic regimen. These impacts include:

1. sub-surface wetland recharge diminishes

2. the wetlands become dependent upon surface re-charge sources and precipitation

3. water enters the wetlands from a few concentrated storm water discharge points

4. stormwater enters wetlands in surges often at increased rates and volume

5. the quality of the stormwater runoff is reduced, delivering toxic contaminants to the wetland.

Any one of these hydrological changes, in itself, is capable of degrading or altering the freshwater wetland environment and creating a mosquito producing habitat.

Preventative wetland protection realized through regulation of stormwater management design is, therefore, the most effective mosquito control procedure in urbanizing areas. Where an existing wetland system is already experiencing the degrading effects of urban runoff, management of the wetland hydrological regimen will provide an effective and environmentally responsible method of mosquito control, without the use of pesticides.

The New Jersey Freshwater Wetlands Protection Act of 1987 has significantly reduced the extent of more physical encroachment and gross alteration in the State's wetlands. In urbanizing areas, however, the adverse impacts of stormwater runoff continues to be a source of degradation and mosquito habitat production in both on-site and impacted off-site wetlands. Consequently, the demand from the general public for mosquito control water management in these impacted wetlands has increased. **N.J.S.A. 26:9-1-31** provides the enabling legislation for mosquito control agencies in New Jersey. Operating under the mandates of Title 26, a county mosquito control agency has broad authority to undertake remedial action "which in its opinion, may be necessary for the elimination of mosquito breeding areas, or which will tend to exterminate mosquitoes within the county"(**N.J.S.A. 26:9-21**).

Ongoing research will hopefully provide continuing insights into wetland functions which will assist in the development of a better understanding of optimum wetland management technology. In the interim, mosquito control agencies are mandated to address wetland mosquito problems, utilizing presently available data, and the best management practices available.

Whether degraded by urban stormwater runoff or not, freshwater wetland mosquito habitat, which impacts residential areas, requires attention. Pesticide usage will remain the dominant mosquito control option during the active mosquito season, between late March and October. However, encroaching development is making pesticide applications increasingly more difficult in these wetlands. Land development trends throughout the state now dictate that effective mosquito control programs include sensitive physical management of freshwater wetland mosquito habitat.

THE NEW JERSEY FRESHWATER WETLANDS PROTECTION ACT OF 1987 (N.J.A.C. 13:9b-1 et seq.)

The intent of the Freshwater Wetlands Protection Act is to preserve the purity and integrity of the freshwater wetlands of New Jersey from random, unnecessary or undesirable disturbance. The ACT does not prohibit all wetland alteration, but does clearly establish three broad criteria by which any proposed wetland disturbance is to be evaluated. Any disturbance will be:

1. planned, rather than random;
2. necessary; and
3. desirable.

Mosquito control management activities in freshwater wetlands must satisfy these criteria. Proper planning, which includes documentation of both the necessity and desirability of wetland management for mosquito control, is a key factor of the Best Management Practices.

The ACT mandates that freshwater wetland management for mosquito control be authorized under a general permit classification on a State-wide or regional basis (Section 23.c). A General Permit #15 has been created to expeditiously allow certain wetland activities for the purpose of controlling mosquito production in the State's freshwater wetlands.

ENDANGERED AND THREATENED SPECIES OF NEW JERSEY

The Freshwater Wetlands Protection Act classifies wetlands into 3 categories:

1. exceptional resource value

2. intermediate resource value

3. ordinary resource value

One criterion of an exceptional resource value wetland shall be that endangered or threatened plant species are present, or it is a documented habitat (determined by the Department to be suitable for breeding, resting or feeding) for threatened or endangered animal species. The other criterion is that it discharges into FW-1 waters and FW-2 trout production waters and their tributaries.

Often, wetland wildlife or plants attain their endangered or threatened status as a direct result of human encroachment and physical stress upon their habitat. Continued industrial and residential development throughout the State will likely place additional stress upon these plants and animals as it also contributes to the formation of mosquito habitat.

County mosquito control agencies should be aware of, and concerned about, any endangered or threatened species within their counties and the potential impact mosquito control activities may have upon them.

A list of the New Jersey flora and fauna presently considered threatened or endangered is provided in Appendix 2 and 3.

Additional information on New Jersey's endangered and/or threatened species may be obtained from the following New Jersey State agencies:

New Jersey Department of Environmental Protection
Division of Fish & Wildlife
Office of Endangered and Threatened Species
Station Plaza 5
PO Box 400
Trenton, NJ 08625-0400
(609) 292-9400

New Jersey Department of Environmental Protection
Division of Parks and Forestry
Office of Natural Lands Management
Station Plaza 5
PO Box 404
Trenton, NJ 08625-0404
(609) 984-1339

New Jersey Department of Environmental Protection
Land Use Regulation
Station Plaza 5
PO Box 401
Trenton, NJ 08625-0401
(609) 292-0060

ADMINISTRATIVE PROCEDURE FOR ISSUANCE OF A GENERAL PERMIT #15 FOR MOSQUITO CONTROL WETLAND MANAGEMENT

A county mosquito control agency shall submit a brief description of the wetland area proposed for management, with supporting mosquito control documentation, to the Administrator of the Office of Mosquito Control Coordination (OMCC), within the Department of Environmental Protection. Following preliminary review and approval by the Administrator, the county agency will proceed with submission of a completed Land Use Regulation Program Application Form (LURP #1), to the Department of Environmental Protection, Land Use Regulation, PO Box 401, Trenton, NJ 08625-0401, for final review and approval.

Each general permit application should contain the following:

Completed LURP-1 Application Form

Permit Application Review Fee (payable to Treasurer, State of New Jersey.)

Certified Mail Return Receipts

Location Map (a copy or portion of a U.S.G.S. Topographic Quadrangle Map with the project site outlined and state plane coordinates.

Original Color Photographs of the portion of the property for which authorization is being applied for.

A Statement of Compliance to determine whether conditions of the general permit (listed in **N.J.A.C. 7:7A-9.2**) for which you are applying will be satisfied per **N.J.A.C. 7:7A-9.5(a)2**.

Site Plan (3 folded copies) detailing existing structures, proposed structures or activities, and a delineation of the wetlands boundary for the area of proposed disturbance.

A signed statement certifying that the proposed activity will not result in any direct or indirect adverse impacts to Swamp Pink (*Helonias bullata*) or its documented habitat in any of the municipalities listed in. **N.J.A.C. 7:7A-9.5(a)2iii(1)**.

A narrative description of the mosquito problem in the area and the best management practices proposed to correct the problem. It is recognized that mosquito control records may be sparse in areas of new mosquito habitat. In general,

however, an effort should be made to provide the most complete records in order to expedite preliminary project review.

Approval Letter from the Administrator, OMCC, DEP documenting a mosquito problem and preliminarily approving the proposed work under the GP #15.

GUIDELINES FOR PREPARATION OF A FRESHWATER WETLAND MOSQUITO CONTROL MANAGEMENT PLAN

A freshwater wetland management application for mosquito control should include not only a general description of the wetland, but enough site specific information to:

1. describe the mosquito producing conditions;

2. determine the appropriate best management practices to be employed; and,

3. facilitate an accurate and timely review of the proposed wetland activity by the N.J. Department of Environmental Protection.

The purpose of the following section is to provide county mosquito control agencies with basic wetland information and guidelines to assist them in establishing the boundary and character of the freshwater wetlands as part of the mosquito control management planning process.

DELINEATION OF FRESHWATER WETLANDS

The New Jersey Freshwater Wetlands Protection Act requires that freshwater wetlands be identified by 3 parameters: wetland hydrology, hydric soil, and wetland vegetation.

Wetland Hydrology

Hydrology may be defined as a science dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere. For the purpose of mosquito control wetland management planning, three wetland hydrologic features should be identified, and recorded. This site data will assist in determining which mosquito control management practice will be most appropriate and effective for a particular site. These features are:

1. the area and depth of surface water or depth to groundwater within saturated wetland soils,

2. the locations of water entering the wetland, and

3. the routes (if any) by which water is discharged from the wetland.

Field inspections are usually required to provide specific details of these site features. However, in many areas much valuable site information is readily available on existing maps. Time spent gathering and reviewing existing area mapping is a solid investment in the development of a sensitive and effective wetland management plan. Information relative to area roadways, drainage features, and residential development, is basic to an understanding of the dynamics which generate and influence wetlands in their urbanizing context. Sources of adverse wetland impacts, which create and maintain mosquito habitat, can often be identified through existing area map review.

Several map information sources are readily available. These include:

1. USGS Quadrangle maps, which contain topographic data, drainage features, and area roadways.

2. Aerial photographs, which provides an overview of all land and drainage features. However, some experience in aerial photo interpretation may be necessary to utilize this resource.

3. Municipal and county topographical mapping is a valuable source of existing land and drainage features, usually providing land surface contours at 1-2 ft. intervals.

4. National Wetlands Inventory Mapping (US Fish and Wildlife Service) is a primary source of approximate wetland delineation and freshwater wetland typing.

5. New Jersey Department of Environmental Protection Wetlands Maps are a source of accurate freshwater wetland delineation.

6. USDA soil conservation soil survey mapping and explanatory reports provide detailed information relative to the locations and types of wetland soils. Soil survey reports and mapping are usually available from the local US Natural Resources Conservation Service (USNRCS) district.

The presence of surface water is not in itself a reliable indicator of the presence of freshwater wetland. For the purpose of mosquito control management within a confirmed wetland, however, measurement of the observed area of surface water mosquito habitat should be one of the initial steps toward the development of a management plan. The area of surface water should, therefore, be determined and sketched onto a management plan drawing. Additionally, all sources of flow into the wetland, as well as discharge

routes, should be added to the plan drawing.

Wetland (Hydric) Soils

Hydric soils develop naturally in wet depressions, on floodplains, on seepage slopes, and along the margins of inland waters. Hydric soil has been defined by the USNRCS' s soil that is either saturated at, or near the soil surface with water that is lacking free oxygen for significant periods during the growing season, or flooded frequently, for long periods, during the growing season. Hydric soils are separated into two major categories on the basis of soil composition. These include:

1. Organic Hydric Soils (Histosols) - Soils which originate from a build up of organic matter, subjected to long periods of flooding, or saturation. These saturated soil conditions impede aerobic decomposition of organic materials such as leaves, stems and roots, and encourage their accumulation as peat or muck, over time. Organic soils are consequently dark in color, poorly drained, and contain partially composed vegetative matter.

2. Mineral Hydric Soils - Soils which are predominantly gray in color with variable "mottling" of bright colors. A typical mineral hydric soil core is composed of a few inches of organic material at the surface underlain by gray, yellow or orange, sands, progressing to sandy clay, and finally clay. The characteristic color mottling usually occurs as an orange or rust "speckling" within the clay or sandy clay layer.

Although surface water, or wetland vegetation can provide observable evidence of a hydric soil condition, accurate soil boundary delineation requires some soil investigation. As previously noted, published soil surveys for each county in the State are available from the USNRCS. In these detailed soil reports, all soils are classified, assigned a name, described and their boundaries mapped. Those soils which tend to be poorly drained are identified. However, soil borings are needed to obtain site specific data such as the hydric soil boundary, its depth, character and depth to ground water.

The hydric soil boundary can be determined by taking hand auger soil borings near the edge of the observed wetland (i.e. wetland vegetation, surface water) and progressively at 5 or 10 foot intervals toward the upland. When a soil boring first indicates only upland soil characteristics, establish the hydric soil boundary midway between that boring and the one preceding it.

The approximated hydric soil boundary is a useful element of a wetland management plan. More important however, are the depth of the hydric soil zone and, if the FWWL is not inundated, depth to groundwater or saturation. The hand auger boring can also provide this data with reasonable accuracy if auger soil samples are observed carefully and measured as they are taken. Ground water observation borings should be taken several hours prior to recording in order to obtain accurate soil saturation levels.

Wetland Vegetation

Wetland vegetation provides the most reliable observed evidence of freshwater wetland conditions. Wetland vegetation is dependent upon seasonal or permanent flooding or sufficiently saturated soils to give it a competitive advantage over upland plant species. Consequently, the wetland boundary is located at the outer limit of wetland vegetation growth. Unfortunately, however, many wetlands do not have abrupt vegetational boundaries, but rather, a transitional area of variable width wherein wetland and upland vegetation intermix. Accurate delineation of the freshwater wetland vegetation boundary requires identification of the existing wetland plants, determination of species density, and establishing the point at which these wetland species are no longer dominant. The mosquito control manager should be familiar with the common New Jersey hydrophytes and their associated plant communities in order to approximate freshwater wetland boundaries.

As part of the National Wetlands Inventory Program, the U.S. Fish and Wildlife Service has compiled a list of nearly 1,000 wetland plants found in the northeast region of the country. This list categorizes plants by their frequency of occurrence in wetlands. Those plants that require saturated soil or standing water and are always found in wetlands are referred to as "obligate" plants (obl.). Plants that can tolerate wet, or dry conditions, are termed "facultative" plants. Facultative plants are divided into three sub-groups:

1. facultative wetland species, (facw) usually found in wetlands (66-99% of the time),

2. facultative species (fac) found in either wetland or upland situations (found in wetlands 33-66% of the time), and

3. facultative upland species (facu), generally found in uplands, but occasionally found in wetlands.

Examples of these wetland associated plant types occurring in New Jersey can be found in Appendix 4.

The wetland boundary is established at the point where wetland indicator plant species no longer have a competitive advantage over upland species. Wetland and upland plants will mix together at this transition zone. When the intermixing of vegetations becomes an even gradient, the boundary is defined. The boundary line, therefore, is drawn at the mid-point of that zone.

In situations where predominantly facultative plant species are found, the ecological association of that community must be examined to determine if the area is a wetland.

SOIL STABILIZATION IN MANAGED WETLAND AREAS

Minimum soil disturbance in freshwater wetlands should be a major objective of mosquito control wetland management practices. However, some disturbance will be inevitable, especially in stream corridor management where channel restoration is undertaken.

Restoration of severely impacted channels in urban or agricultural areas may require both sediment removal, and "resculpting" of natural channel meanders. Both procedures generate considerable spoil volume. Where excavated materials cannot be feasibly removed from the floodplain, they should be regraded to a depth of no greater than 4 in. Since a considerable area may be disturbed by the regrading process, stabilization of these areas is crucial, especially in a stream corridors subject to the scouring effects of periodic flooding.

Usually, indigenous floodplain vegetative species will revegetate the disturbed areas. However, natural revegetation may require considerable time. It is good practice, therefore, to supplement the natural revegetation process with the establishment of hardy, soil binding, species of grass capable of thriving in saturated soils. Wetland tolerant grasses serve two purposes:

1. they provide soil binding root/rhizome systems, and

2. they provide food and cover for wildlife.

Several species of grass have been designated by the USNRCS as being particularly effective wetland soil binders and good wildlife food and cover. A list of the grasses recommended by the USNRCS for soil conservation in the northeast US is provided in Appendix 5. A mosquito control agency may find it necessary to experiment with varying mixtures of these and other grasses, in order to find the

best blend for site specific conditions.

The following blend, developed by the Rutgers University Turf Management Department, has proven very successful for stabilizing fresh cut stream banks and graded spoil, and provides excellent wildlife cover.

60% Perennial Rye Grass
8% Kentucky Blue Grass
8% Penn Red Fescue
4% Red Fescue (creeping)
20% Reed Canary Grass

The proper scheduling of wetland management projects is also a very important soil stabilization factor. Excavation, and regrading of the excavated spoil, should be completed early enough in the growing season to allow adequate time for germination and establishment of new vegetation. In the absence of adequate soil stabilization, stream corridors, subject to floodplain scouring, may suffer considerable winter erosion.

VEGETATION DISTURBANCE

Wetland waterway restoration, as well as floodplain wetland management, may entail a moderate amount of vegetative disturbance. Any wetland management plan must place a high priority on the preservation of existing vegetation. Particular attention should be directed toward the protection of the larger woody species. As a general management principle, the preservation of all trees should be a primary objective. Though selective removal of some smaller trees (4 in. diameter or less) will often be necessary, cutting should not be done randomly. Wetland management practices should attempt to limit vegetation disturbance to the grasses and understory shrub-scrub plant varieties.

EXCAVATION EQUIPMENT

Removal of sediment from impacted waterways usually requires excavation equipment with a maximum reach capability. Adequate reach capability is especially desirable in wetland management projects where channel resculpting may require reaching over, or around, vegetative stands, as well as the selective placement of spoil beyond a 25 ft. top of bank buffer. Wetland management equipment should also present low ground pressure to minimize soil compression and root damage to the surrounding vegetation.

BASIC PRINCIPLE OF WETLAND MANAGEMENT FOR MOSQUITO CONTROL

The Freshwater Wetlands Protection Act mandates that freshwater wetlands be identified and delineated by using 3 parameter approach (hydrology, soils and vegetation) as established by the US Environmental Protection Agency.

The Act defines a freshwater wetland as an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and does normally support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation. This definition indicates clearly that standing surface water is not a necessary feature of freshwater wetland hydrology, since sub-surface ground water saturation will also support some hydrophytic vegetation.

The Best Management Practices for Mosquito Control and Freshwater Wetland Management have been developed upon the principle of converting mosquito producing surface inundated wetlands to ground saturated wetlands. This management principle provides for both the elimination or reduction of mosquito producing surface water, while preserving the essential saturated wetland character and function. This management principle has little in common with traditional land reclamation practices.

The following practices are intended to serve as an alternative to continued pesticide usage for the control of mosquitoes in the State's freshwater wetlands, particularly in those wetlands being impacted by urban development.

BASIC PRACTICES FOR FRESHWATER WETLAND MOSQUITO CONTROL MANAGEMENT

Shallow Channel Restoration

The impact of accumulated sediment within the stream channels of a wetland system may require restoration of the waterway prior to management of the floodplain mosquito habitat. The removal of up to 2 ft. of channel sediment (as per NJDEP Stream Encroachment Regulations, **N.J.A.C. 7:13**) is generally a reasonable standard for wetland waterway management.

The primary objective of wetland channel restoration for mosquito control is to restore flow within the stream banks, while maintaining the channel water level within or near the hydric soil zone of the floodplain. The hydric soil zone depth can be reasonably estimated on the basis of soil data obtained from shallow soil borings taken near the channel.

Some creativity may be required to establish and maintain adequate water depth within a newly restored channel. This is largely due to the fluctuations in flow normally experienced by small waterways during storm events or drought conditions. Also, as small watersheds experience urbanization, these fluctuations naturally increase. Care should be taken to establish the desired channel water level during a period of normal flow so that the adjusted water level will be sustained adequately to ensure the integrity of the wetlands. A minimum channel water depth of 2 ft. is suggested for small streams in order to restore or enhance fish habitat.

The Drainage Swale

The swale is an effective wetland management tool because of its ability to accomplish the same objectives as a drainage ditch, but with a greater degree of sensitivity to its surrounding environment. Lacking defined banks, the drainage swale can be fashioned to blend into the wetland topography, while accomplishing its management functions of concentrating and removing accumulated surface water.

Freshwater wetland management swale design should be adapted to accommodate site specific conditions. However, the following swale design guidelines are recommended for typical mosquito control management sites:

1. The bottom of the swale (swale invert) should be set as high in the hydric soil zone as site grade limitations allow. In general, a swale depth of

between 6-12 in. is recommended.

2. Swales should be constructed in meandering paths, avoiding vegetative stands and trees, whenever possible.

3. All excavated material should be regraded on-site and stabilized with moisture tolerant grass varieties. Site stabilization or re-vegetation may also include planting of wetland shrubs or small trees which are indigenous to the area.

The Low Level Management Sill

Topography, hydrology, or soil conditions may make it difficult to maintain adequate ground water saturation within managed wetlands. Excessive dewatering of the hydric soil zone may occur as a result of the following conditions:

1. General lowering of ground water due to storm drainage alterations, such as storm sewer installation, etc.

2. The presence of permeable organic hydric soils (peat)

3. Wetland surface gradients exceeding 1%

A "low level sill", or weir, is a simple structure of wood, stone, or concrete which can be installed in a management swale to assist in stabilizing soil saturation. Creative combinations of shallow swales and low level management sills can be used to "fine tune" the wetland management water balance process of converting inundated wetlands to saturated wetlands.

Sill installation depth should be deep enough to restrict surface flow within the management swale and also impede movement of sub-surface flow within the wetland soil. Optimum installation depth is determined by the site soils and hydrology, as well as the desired depth of water to be retained within the swale. Some experimentation may be necessary to determine the best installation. The depth to ground water, and hydric soil zone (depth) should be determined and the sills installed to create the desired ground saturation level. A general recommendation is to install management sills so as to provide a flow barrier extending between 12 and 14 in. below the swale bottom.

Where wetland surface grade will cause even a shallow swale to excessively dewater the hydric soil, multiple management sills can be used to lower the water table in steps while maintaining soil moisture in the higher elevations of the

wetland system. A surface gradient in excess of 2% will likely require the use of tandem sills.

Wetland management sills and swales in urbanizing areas may be subject to periodic surges from stormwater culverts. Damage to the sills may occur in the form of washouts or undercutting of the sill. Wetland management systems installed in unstable organic soils, and those receiving runoff from large culverts will likely require additional stabilization protection.

BEST MANAGEMENT PRACTICES FOR MOSQUITO CONTROL IN STREAM CORRIDOR WETLANDS

Sediment choked channels artificially elevate floodplain water levels, which reduce the flood storage capacity of the floodplain, contribute to road flooding, and often generate extensive mosquito habitat.

Restoration of stream channels may, therefore, be necessary prior to management of the floodplain wetlands. It should be emphasized that the objective of mosquito control stream corridor management is not primarily to improve channel flood passage, but rather to return normal stream flow to an inbank condition in order to then convert inundated wetlands to soil saturated wetlands. The following stream corridor management practices and guidelines are to be applied with sensitivity and creativity toward that objective.

1. Minimum Vegetative Disturbance - The wetland management plan should require minimum feasible vegetation disturbance.

   A. The initial goal is no tree cutting at all. Whenever possible, limit disturbance to grasses, and understory of woody shrubs such as Huckleberry, Honeysuckle, Alder, etc.

   B. A compromise selective cutting of trees under 4 in. in diameter may be necessary. The management plan should designate where larger trees are proposed for removal.

   C. Where feasible, clear one bank only. On meandering channels, alternate the bank cleared, preserving larger trees and vegetation on the outside of channel bends.

2. Sediment Containment - Place sediment screens in channel prior to restoration work.

A. The channel volume, flow, and amounts of suspended sediments, will dictate the most effective type of sediment screen to be employed. In the presence of substantial flow, crushed stone or timbers placed upstream of the sediment screen may be necessary to absorb the thrust of channel flow. Multiple screens of various fabric textures are recommended for channels experiencing heavy sediment draft.

   Hog wire or an equally rigid fence material is recommended for support of the filtering fabric. Where substantial channel flow is anticipated, additional timber supports should be added to buttress the filter frame. Numerous filter fabrics are available, but care should be taken to select one which is capable of passing the anticipated normal channel flow. Burlap has been found to be a good filter fabric for general channel usage.

B. Sediment screens should be installed a reasonable distance downstream of excavation equipment in order to take advantage of natural settling of suspended material. This distance should vary with site conditions, and the anticipated rate of equipment progress. Sediment screens should be inspected daily, and the filter fabric replaced when clogged with sediment "fines".

C. Where possible, utilize road culverts and bridge abutments to anchor sediment screens. Such structures should not be used without approval of the appropriate authority.

D. The filter fabric should always be removed from its frame when <u>significant</u> precipitation is anticipated, or the sediment screen may cause increased flooding. Removal of the entire frame should be considered when <u>major storm events</u> are predicted.

3. <u>Channel Restoration</u> - The following procedures are recommended for restoration of waterways damaged by the impacts of urbanization or agricultural sedimentation.

   Some procedures, such as sediment containment, and restabilization of disturbed areas are applicable to all management sites.

   The creation or restoration of channel meanders,

however, will usually be more limited due to site conditions and regulatory restrictions. The objective of wetland channel restoration is to create a naturalistic waterway, which will then facilitate reduction of floodplain mosquito habitat with minimum floodplain wetland disturbance. Recommended channel restoration procedures include:

A. Prior to channel restoration, determine depth of floodplain saturated soils. The various soil horizons can be determined by taking hand auger borings throughout the floodplain.

B. Sediment removal operations should proceed downstream trapping sediments ahead of excavation.

C. The restored channel water level should be established and maintained within the range of the floodplain hydric soil zone.

D. Natural channel meanders should always be preserved. Further, where natural meanders have been lost as a result of channelization or heavy sedimentation, their restoration should be attempted.

E. Where soil conditions and stream bed gradient allow, construct a pool-riffle configuration within the restored channel bed. Alternating pools and riffles within a channel bed combine the benefits of both shallow moving water and the more stable, deep-water fish habitat.

   A pool-riffle pattern should not be established randomly within a restored channel, but should be integrated into the natural variations of flow velocity within stream meanders, and the straighter runs between them.

   Technical assistance for channel restoration practice is available through the USNRCS, and some municipal or county engineering agencies.

F. Regrade and stabilize excavated materials. Regraded excavated materials should be no more than 4 in. deep. Seed disturbed areas with wetland tolerant grasses.

4. Floodplain Mosquito Habitat Management - The procedures for management of productive floodplain mosquito habitat include:

   A. Excavate shallow swales (6 to 12 in.) to convey surface water to stream channel.

   B. Install low level sills within swales to maintain hydric soil saturation as required.

   C. Minimize vegetative disturbance. Utilize light excavation equipment or hand labor in very sensitive areas, meandering swales around trees and dense woody vegetative stands.

   D. Extend swales to each wetland recharge source i.e., storm drainage culverts and natural gullies.

   E. Regrade and stabilize excavated areas with wetland tolerant grass species.

BEST MANAGEMENT PRACTICES FOR MOSQUITO CONTROL IN PALUSTRINE FRESHWATER WETLANDS

The management of mosquito habitat in Palustrine Freshwater Wetlands employs the same basic practices utilized in floodplain wetlands. However, root systems of the larger and more dense vegetation, common to forested wetlands, may impede the construction of shallow swales. Management of some forested wetlands may be accomplished more effectively by improving existing deteriorated woodland ditches or swales, and connecting them to drainage culverts discharging from developing areas. This management procedure may prove more efficient as well as less destructive to the root systems of wetland vegetation than would new swale excavation.

Retention of hydric soil saturation may be enhanced by the installation of management sills within the restored woodland ditches, or within naturally formed swales.

1. Enhancement of Existing Drainage Systems

   A. Locate sources of water entering forested wetlands such as road culverts, farm ditches ground springs, detention basin discharges, etc.

   B. Locate existing discharge routes.

C. Undertake enhancement of forest discharge routes utilizing low level sills to regulate the discharge from the wetland.

D. Regrade and stabilize disturbed areas with moisture tolerant grass.

2. Creation of New Swale System

A. Determine discharge point from wetland.

B. Utilizing hand soil borings, establish depth of hydric soil zone.

C. Establish lowest elevations throughout the wetland.

D. Excavate swale (6 - 12in. depth) from discharge point and through low elevations and extend swales to each inlet culvert or gully. Also, meander swales around large trees or woody bushes and shrubs.

E. Install low level sills to regulate wetlands withing the swales to enhance soil saturation.

F. Regrade disturbed soil and stabilize with wetland tolerant grass species.

BEST MANAGEMENT PRACTICES FOR MOSQUITO CONTROL IN ISOLATED FRESHWATER WETLANDS

An isolated wetland is one which has no known drainage outlet to a stream or another nearby wetland area. It may be desirable to manage an isolated wetland due to the presence of mosquito habitat which impacts nearby residential areas. The "adjusted resource value" of an isolated wetland in, or near, a developing area may be assessed on the basis of the following criteria: the area of wetland, the quality of the wetland, and the extend of the wetland's mosquito impact upon area residents.

1. Standard Surface Culvert Outlet

A. Provide culvert outlet through confining high ground, roadway, utility easement, etc.

B. Establish culvert outlet invert 12-14 in. below the wetland surface, using the hydric

soil zone depth as a guide,

C. Excavate shallow tributary swales to each storm drainage culvert recharging the wetlands in order to relieve existing standing surface water,

D. Regrade and stabilize disturbed areas.

2. Infiltration Enhancement (Perched System) - If the ground water level is low enough infiltration from an isolated freshwater wetland may be enhanced by lateral outlets to pervious upland soils outside of the wetland soil boundary, or by vertical outlets to subsoils.

3. Lateral Drainage:

A. use hand borings to establish depth of hydric soil and depth to ground water.

B. provide controlled outlet to permeable subsoil.

C. excavate shallow swales to wetland recharge culverts.

D. restabilize disturbed areas.

4. Vertical Drainage:

A hydraulic connection between a confirmed wetland and underlying pervious soils may be established by installing vertical drainage pipes through the hydric soil strata. The upper end of the pipe should be used to maintain the desired ground water saturation level within the wetland. Care should be taken to "repack" the impervious soil around the vertical discharge pipe in order to prevent excessive dewatering of wetland.

BEST MANAGEMENT PRACTICES FOR MOSQUITO CONTROL IN CONSTRUCTION DISTURBED FRESHWATER WETLANDS

The degrading impacts of construction on wetlands encompass a broad spectrum ranging from the subtle concentration of heavy metals and hydrocarbons, to the obvious sediment loading or filling of streams and waterways. Mosquito control agencies have generally reacted in a "janitorial

role" to clear sediment and debris from waterways, thus making possible remedial mosquito source reduction within stream corridors and wetlands. Though remedial mosquito control is necessary where wetlands have already been impacted, a preventative approach to mosquito control has been demonstrated to be an effective abatement strategy for areas where the state's wetlands are under the stress of urbanization. Consequently, Part 2 of this section is considerably more detailed in order to provide guidance in the development and implementation of a preventative mosquito control program for freshwater wetlands.

1. Post Construction Management (Remedial Management)

   Recommended procedures for wetland management for mosquito control in construction impacted areas:

   A. Identify the sources of the following wetland degradation agents such as:

      sedimentation
      "filling"
      site development
      linear development
      road bed construction
      sanitary sewer, utility, installations
      urban quality stormwater runoff
      septic leachate
      other point or non-point sources

   B. Develop a management plan which includes a sketch plan of wetland area. (Sketch details onto municipal tax maps, scale 1" = 100' or 200' and a brief description of, wetland impacts, existing mosquito problems, and proposed management practices.

   C. Implement the appropriate wetland management practices to reduce the mosquito habitat.

2. Pre-construction Review (Preventative Management)

   The effective management of freshwater wetlands for mosquito control begins with minimizing adverse wetland impacts before they occur. Experience has shown that properly located, designed, constructed and maintained stormwater management facilities help to reduce the degrading impacts upon wetlands adjoining developed areas.

   It should be noted that indiscriminate discharge of urban storm runoff to wetland ecosystems is common practice today. And, the continuing discharge of contaminant-laden stormwater into

freshwater wetlands is having a significant, immediate, as well as cumulative, impact upon mosquito production in urbanizing areas. In view of this situation a pre-construction, site plan review procedure, should logically be a part of an integrated mosquito control program in New Jersey.

A. Sub-division and Site Plan Review Program - when correctly, and consistently implemented, a site plan review program is very effective mosquito control procedure. In New Jersey, mosquito control agencies do not possess direct land use regulatory authority for control of stormwater management practices on development sites. However, **N.J.S.A. 26:9** grants authority to county mosquito commissions to perform all acts which in their opinion will exterminate mosquitoes or which will tend to exterminate them. Mosquito commissions are also endowed with the same authority as municipal boards of health in matters relative to mosquito control. However, mosquito control agencies can also effectively utilize the authority of county and municipal planning and engineering agencies by joining a site plan review team.

Mosquito control agencies possess unique perspective, as agencies which regularly respond to the immediate and cumulative public health impacts of construction stormwater management practices. When able to articulate this perspective, mosquito control agencies can contribute valuable, fresh insights to planners and engineers. More quality mosquito control can often be accomplished with one site plan review report than by months of expensive remedial field work. Consequently, the disciplined review of stormwater management systems on proposed development sites is a recommended best management practice.

B. Establishing A Review Program - The following procedure is recommended for initiating and administering a site development plan review program for mosquito control.

(1) Inform the county planning agency of the mosquito agency's desire to provide advisory input on the mosquito-related impacts of proposed stormwater management systems. This

initial communication should emphasize that the objective of this advisory input is to enable the mosquito control agency to more effectively protect the health and comfort of the public, and protect our water resources. A review program can be initiated at the municipal level rather than with the county. A county level program is preferable, however, since the county planning agency's jurisdiction boundaries coincide with those of the mosquito control agency, and most major development plans are normally forwarded to the county from its municipalities. Municipal relationships may naturally develop as the county reports reflect mosquito control agency comments, which will be of interest to local environmental commissions or engineers.

(2) Request a set of preliminary site development plans for each proposed development. These plans contain the proposed stormwater management information necessary for mosquito control agency review.

(3) A written site review report should be forwarded to the county planning agency identifying existing on-site mosquito problems, mosquito problems on adjoining property and potential mosquito problems generated by the proposed stormwater management plan (SWMP) or site grading.

(4) The review report should suggest modifications to the proposed SWMP which will either reduce or eliminate the potential mosquito problem.

(5) Provide the county planning board site plan review staff with a county map identifying areas of major existing mosquito problems which will be sensitive to development impacts. Major areas of freshwater wetlands and deteriorated stream corridors should be designated as "mosquito sensitive".

C. Site Plan Review Report - Site plan review for mosquito control should concentrate upon proposed stormwater management practices and structures, and involve other aspects of the site plan only as they may affect mosquito control.

The site plan review report should evaluate the following:

(1) On-site and adjoining waterways
 their existing condition
 potential impacts of any proposed alteration

(2) On-site floodplains,
 existing mosquito habitat
 presence of FWWL
 potential impacts on mosquito production by stormwater discharges or filling

(3) Area topography
 potential impounding of surface runoff
 upgrade of site
 potential inundation of downgrade areas by site discharge

(4) Stormwater management facilities
 Basin design
 potential in-basin mosquito habitat
 provision for maintenance

 Basin location
 relative to ground water table
 subject to excessive sedimentation
 quality of incoming water

 Relative to FWWLs
 potential dewatering of FWWL
 direct discharge to FWWL (contaminant impacts)
 water level fluctuations in wetlands
 general FWWL damage

 Discharge of basin
 adequate rate to prevent mosquito habitat
 adequate rate to allow maintenance
 outlet protection for small orifice i.e., trash rack

(5) FWWLs (on-site and off site)
 existing mosquito problem
 stormwater impacts upon mosquito production

BEST MANAGEMENT PRACTICES FOR MOSQUITO CONTROL IN STORMWATER FACILITIES

In the absence of design and maintenance standards, many stormwater management facilities (SWMF) throughout the State have developed into freshwater wetlands. Many such basins are completely unmaintainable, being overgrown with aquatic vegetation, and often recharged by contaminant-laden urban or industrial quality storm runoff.

These basins often provide ideal habitat for mosquitoes. Mosquito productive stormwater management facilities (SWMF) are placing a continually increasing burden upon county mosquito control agencies. New construction, in the absence of regional stormwater management planning, will require the construction of additional on-site facilities.

A New Jersey Department of Environmental Protection funded study of the social, and public health impacts of existing New Jersey Stormwater Management facilities was completed in 1988. Standards for facility design, construction, and maintenance, are now available to developers, engineers and planning agencies. These standards provide guidance for the construction and maintenance of new facilities and the upgrading of existing problem basins.

There are three types of stormwater facilities:

1. Detention basins, designed to be dry between storm events;

2. Retention basins or permanent ponds; and

3. Recharge basins, designed to percolate storm runoff into underlying soils.

To function efficiently, a stormwater management facility must:

1. Be correctly designed for the intended function.

2. Be correctly sited relative to the area hydrology and soil types.

3. Be constructed according to the engineering plan.

4. Be adequately maintained for continued functioning.

Freshwater wetland mosquito habitat will seldom develop in a facility which has been correctly designed, situated, constructed, and maintained. However, many facilities are

mosquito problems, placing an increasing burden upon county mosquito control agencies' larvicide programs. Major basin modifications may be necessary to eliminate standing water. In many facilities minor grading or installation of low flow channels may remedy the condition.

1. Mosquito-Producing Stormwater Facilities

A. Evaluate public need for mosquito control

(1) Basin location
residential area
commercial area
industrial area

(2) Mosquito species produced

(3) Public opinion regarding the problem basin

(4) Assess existing temporary control procedures: i.e., larviciding frequency, access to basin and effectiveness of pesticide applications, and

B. Determine cause of basin failure: i.e., failure to completely discharge, or discharge too slowly, aquatic vegetation, overgrowth, etc.

(1) Design

inadequate floor gradient
outlet elevation too high
no inlet stabilization
no trash rack protection

(2) Siting

high ground water table
receding ground water table
excessive sedimentation
basin floor "sealed" (recharge basin)
heavy pollutant loading (retention or recharge basin)
off-site receiving system inadequate
inadequate recharge

(3) Construction

basin floor grading
depressions, inadequate gradient in basin floor
incorrect low flow channel grade

basin discharge elevation lower than receiving stream
basin water depth too shallow
soil recharge enhancement needed

(4) Maintenance

excessive sedimentation
sealed percolation basin floor
heavy vegetation(retention basin)
heavy frost damage to low flow channel or outlet debris accumulation
vandalism

C. Select mosquito abatement option

(1) Continue pesticide applications

(2) Evaluate feasibility of facility modification

D. Establish basin ownership

(1) Public ownership-municipal

(2) Private ownership-commercial, industrial

(3) Homeowners association-condominiums, apartments

(4) Public agency ownership-New Jersey Department of Transportation, (highway basins)

E. Research existing maintenance contracts, agreements, bonds or escrow accounts for potential management funding.

2. Stormwater Facility Basin Modification

Mosquito control agencies do not normally perform regular periodic maintenance of stormwater facilities. However, modification of existing mosquito producing facilities may be a practical option to continuing pesticide control measures, particularly where basin conditions, or location, limit the effectiveness of the larvicide effort.

Basin modification plans should be developed in cooperation with other public agencies such as the municipal engineers office and the soil conservation district. Within a cooperative plan, however, the focus must be kept upon mosquito abatement as the priority objective.

The New Jersey Wetlands Protection Act (Section 23:c.8) provides that the maintenance and repair of stormwater management facilities, which contain freshwater wetlands, shall be authorized by a General Wetland Permit.

3. Stormwater Facility Management Procedures

A. Remove impediments such as sediment and debris to restore complete basin discharge flow.

B. Reconstruct basin floor

(1) establish low flow swale from inlets to discharge point.

(2) stabilize low flow channel with crushed stone or reinforced concrete Min. 1-2% slope (grassed 3)

(3) establish lateral floor gradient 1-2% from toe of side slope to low flow channel.

(4) provide stabilization at inlets with crushed stone and stabilize basin floor with grass seeding.

C. Where basin retains shallow water due to a high water table, there are two remedial options.

(1) site conditions allowing, raise floor of basin to at least one foot above ground water elevation and modify facility to function as dry basin.

(2) deepen basin

(i) to minimum 5 foot permanent water depth.
(ii) establish predaceous fish population

D. Where recharge basin floor has "sealed"

(1) "scarify" basin floor to restore percolation to subsoil

(2) clean or replace seepage pits

(3) install recharge enhancement trenching in graded floor

(4) fill trench with clean stone, replace vegetative stabilization.

E. In residential areas, where off-site basin discharge is possible, install small diameter outlet pipe with gate valve control.

MITIGATION WETLANDS

With recognition that some freshwater wetland loss may accompany land development, the Freshwater Wetlands Protection Act requires the creation, restoration or enhancement of wetlands of equal ecological value. Such compensatory wetlands are created to mitigate or reduce the ecological impact of freshwater wetland loss within the system.

Mitigation wetlands are of special concern to mosquito control agencies for three reasons:

1. The art of freshwater wetland creation is a relatively new practice, and some developers are unfamiliar with correct procedures.

2. FWWL replacement obligations may be imposed on a 2 to 1, or 3 to 1 ratio. That is, two acres of man-made wetland are required to compensate the one are of natural wetland lost. Under pressure satisfy mitigation obligations, land developers may construct new wetlands incorrectly, resulting in new mosquito habitat near residential areas.

3. A balanced freshwater wetland ecosystem, which encourages mosquito predaceous species, may take years to become established.

These factors indicate that there is presently a high potential for mosquito problems in man-made wetlands. A first step toward addressing this potential problem requires that any proposed new wetland construction in or near to residential areas should be reviewed carefully by local public health and mosquito control agencies. In order to encourage and assist such review, the Freshwater Wetlands Protection Act Rules requires that copies of all individual Freshwater and Open Water Fill Permit applications be forwarded to the county mosquito control agency.

The N.J. Department of Environmental Protection's Land Use Regulation Program's Application Support Unit also forwards copies of permit applications to the Office of Mosquito Control Coordination for its review and comments.

The county mosquito control agency in cooperation with the municipal or county health department should:

1. Establish a file of proposed mitigation wetland activities within their jurisdiction.

2. Request adequate time to review mitigation construction plan proposals prior to permit or site plan approval.

3. Become familiar with basic mitigation techniques, utilizing available professional assistance if needed.

4. Develop in-house capability to evaluate wetland construction plans, and aggressively request modifications which,in its opinion, will prevent the creation mosquito habitat.

Interim mitigation wetland research findings are released periodically by the U.S. Environmental Protection Agency's Environmental Research Laboratory. For current information, and to be placed on the program mailing list, contact:

Wetland Research Program
Environmental Research Laboratory
200 S.W. 35th Street
Corvallis, Oregon 97333
Phone: (541) 754-4600

In the absence of detailed mitigation guidelines, the following design criteria are recommended to minimize potential mosquito production in manmade FWWL wetland creation projects:

1. Proposed wetland should have adequate surface gradient to prevent standing surface after accumulations. A 2% grade is recommended.

2. Provide diversity within the wetlands by creating or improving an open water receiving area, such as a pond or stream. The open water should have adequate depth to support predaceous fish species and shallows (1 ft. $\pm$) to encourage waterfowl usage.

3. Utilize wetland grass species and shrub plantings to stabilize new wetland surface.

APPENDIX 1

DEFINITIONS

Channel Restoration - removal of sediment and debris from a waterway in order to return normal stream flow to within the banks. Preservation of existing channel meandering alignments is recommended.

Channelization - the straightening, deepening, and enlarging of a waterway to allow increased flood water passage. Channelization may also include creation of a trapezoidal channel section stabilized by concrete.

Cumulative Adverse Impacts - the destructive effects resulting from the repetition of minor damage.

Delineated Wetland (FWWL) - the destructive effects resulting from the repetition of minor damage.

Endangered Species - those species who prospect for survival in the state are in immediate danager because of a loss or change of habitat, over exploitation, predation, competition or disease. Immediate assistance is needed to prevent extinction.

FW-1 Waters - fresh waters that originate in and are wholly within Federal or State Parks, forests, fish and wild-life lands, and other special holdings, that are to be be maintained in their natural state of quality (set aside for posterity, and not subjected to any waste-water discharges of human origin), as designated in the Department's Surface Water Quality Standards, **N.J.A.C. 7:9-4**.

FWWL - freshwater wetlands.

Hydric Soil - a soil that in its undrained condition is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation.

Hydric Soil Zone - the depth of hydric, or wetland soil.

Hydrophytic Vegetation - plants adapted to growth and reproduction under periodically saturated root zone conditions during at least a portion of the growing season.

Infiltration - the movement of water from the land surface into underlying soils.

Mitigation Wetland - freshwater wetland which is either created, restored, enhanced or deeded to public ownership, as compensation for wetland destroyed.

Saturated Soil - soil lacking free oxygen due to sustained surface inundation, or ground water saturation at or near the ground surface.

Stormwater Contaminants - dissolved or suspended substances commonly present in stormwater runoff from urbanized or active agricultural areas. Typical urban source contaminants include hydrocarbons in various forms, road salts, pesticides, and heavy metals. Agricultural source contaminants include pesticides, animal waste and sediment.

Stream Corridor - the channel, banks, and floodplain of a flowing stream.

SWMF - stormwater management facility. Usually reference is to a detention basin.

The Act - the New Jersey Freshwater Wetlands Protection Act of 1987 (**N.J.A.C. 13:9b-1 et seq**.).

The Department - the New Jersey Department of Environmental Protection.

Threaten Species - those species identified pursuant to the Endangered and Nongame Species Conservation Act, **N.J.S.A. 23:2A-1 et seq**., or those identified pursuant to the endangered Species Act of 1973, 16 U.S.C. 1531 et al.

Urban Stormwater Runoff - surface drainage water from the paved streets, driveways, parking lots and commercial sites within developed areas.

Wetland Hydrologic Regimen - the movement of surface or ground water into, within, or from a wetland area.

APPENDIX 2

NEW JERSEY PLANTS UNDER REVIEW FOR FEDERAL LISTING AS ENDANGERED SPECIES*

Common Name	Scientific Name
Sensitive Joint Vetch	*Aeschynomene virginica*
Sea-beach Pigweed	*Amaranthus pumilus*
Sand Grass	*Calamovilfa breviplis*
Long's Bitter Cress	*Cardamine longii*
Barrett's Sedge	*Carex barratii*
Variable Sedge	*Carex polymorpha*
Parker's Pipewort	*Eriocaulon parkeri*
Pine Barrens Boneset	*Eupatorium resinosum*
Darlington's Spurge	*Eurphorbia purpurea*
Pine Barren Gentian	*Gentiana autumnalis*
Eaton's Quillwort	*Isoetes eatonii*
New Jersey Rush	*Juncus caesariensis*
Boykin's Lobelia	*Lobelia boykinii*
Nuttall's Micranthemum	*Micranthemum micranthemoides*
Torrey's Muhly	*Muhlenbergia torreyana*
Bog Asphodel	*Narthecium americanum*
Hirst's Panic Grass	*Panicum hirstii*
Jacob's Ladder	*Pelemonium vani-bruntiae*
Awned Meadow Beauty	*Rhexia aristosa*
Knieskern's Beaked Rush	*Rynchospora knieskernii*
Curly Grass Fern	*Schizaea pusilla*
Chaffseed	*Schwalbea americana*
Long's Bulrush	*Scirpus lingii*
Spreading Globe-flower	*Trollius laxus laxus*

FEDERALLY THREATENED SPECIES

Swamp Pink	*Helonias bullata*****

*Further information about rare plants is available through the Office of Natural Lands Management, N.J. Department of Environmental Protection, PO Box 404, Trenton, NJ 08625-0404.

**The Swamp Pink was listed as a federally threatened species on September 9, 1988.

APPENDIX 3

ENDANGERED/THREATENED FAUNA OF NEW JERSEY

The following species are listed as endangered/ threatened on the New Jersey State list as of June 3, 1991.

AMPHIBIANS

Endangered

Tremblay's Salamander, *Ambystoma tremblayi*
Blue-spotted Salamander, *Ambystoma laterale*
Eastern Tiger Salmander, *Ambystoma t.tigrinum*
Pine Barrens Treefrog, *Hyla andersonii*
Southern Gray Treefrog, *Hyla chrysocelis*

Threatened

Long-tailed Salamander, *Eurycea longicauda*
Eastern Mud Salamander, *Pseudotriton montanus*

REPTILES

Endangered

Bog Turtle, *Clemmys muhlenbergi*
Atlantic Hawksbill, *Eretmochelys imbricata***
Altantic Loggerhead, *Caretta caretta***
Atlantic Ridley, *Lepidochelys kempi***
Atlantic Leatherback, *Dermochelys coriacea***
Corn Snake, *Elaphe g. guttata*
Timber Rattlesnake, *Crotalus h. horridus*

Threatened

Wood Turtle, *Clemmys insculpta*
Atlantic Green Turtle, *Chelonia mydas***
Northern Pine Snake, *Pituophis m. melanoleucus*

BIRDS

Endangered

Pied-billed Grebe, *Podilymbus podiceps**
Bald Eagle, *Haliaeetus leucocephalus***
Northern Harrier, *Circus cyaneus**
Cooper's Hawk, *Accipiter cooperii*
Red-shouldered Hawk, *Buteo lineatus* (breeding)
Peregrine Falcon, *Falco peregrinus***
Piping Plover, *Charadrius melodus***
Upland Sandpiper, *Bartramia longicauda*
Roseate Tern, *Sterna dougallii*
Least Tern, *Sterna antillarum*
Black Skimmer, *Rynchops niger*
Short-eared Owl, *Asio flammeus**
Sedge Wren, *Cistothorus platensis*
Loggerhead Shrike, *Lanius ludovicianus*
Vesper Sparrow, *Pooecetes gramineus*
Henslow's Sparrow, *Ammodramus henslowii*

Threatened

American Bittern, *Botaurus lentiginosos**
Great Blue Heron, *Aredea herodias**
Little Blue Heron, *Egretta caerulea**
Yellow-crowned Night Heron, *Nyctanassa violaceus*
Osprey, *Pandion haliaetus*
Northern Goshawk, *Accipiter gentillis*
Red-shouldered Hawk, *Buteo lineatus* (Non-breeding)
Black Rail, *Laterallus jamaicensis*
Long-eared Owl, *Asio otus*
Barred Owl, *Strix varia*
Red-headed Woodpecker, *Melanerpes erythrocephalus*
Cliff Swallow, *Hirundo pyrrhonota**
Savannah Sparrow, *Passerculus sandwichensis*
Ipswich Sparrow, *Passerculus sandwichensis princeps*
Grasshopper Sparrow, *Ammodramus savannarum*
Bobolink, *Dolichonyx oryzivorus*

FISH

Endangered

Shortnose Sturgeon, *Acipenser brevirostrum***

Threatened

Brook Trout, *Salvelinus fontinalis*

MAMMALS

Endangered

Bobcat, *Lynx rufus*
Eastern Woodrat, *Neotoma floridana*
Sperm Whale, *Physeter macrocephalus***
Fin Whale, *Balaenoptera physalus***
Sei Whale, *Balaenoptera borealis***
Blue Whale, *Balaenoptera musculus***
Humpback Whale, *Megaptera novaeangliae***
Black Right Whale, *Balaena glacialis***

INVERTEBRATES

Threatened

Mitchell's Satyr (butterfly), *Neonympha m. mitchellii***
Northeastern Beach Tiger Beetle, *Cicindela d. dorsalis*
American Burying Beetle, *Nicrophorus americanus***
Dwarf Wedge Mussel, *Alasmidonta heterodon***

* Only breeding population considered endangered or threatened

**Federally endangered or threatened

APPENDIX 4

FRESHWATER WETLAND PLANT TYPES OCCURRING IN NEW JERSEY

1. Wetland trees

Red Maple, *Acer rubrum*
Willows, *Salix spp.*
Back Spruce, *Picea marina*
Swamp White Oak, *Quercus bicolor*
Red Ash, *Fraximus pennsylvanica*
Black Ash, *Fraximus nigra*
Silver Maple, *Acer saccharinum*
American Elm, *Ulmus americana*
Larch, *Larix laricina*
Black Gum, *Nyssa sylvatica*
White Cedar, *Chamaecyparis thyoides*

2. Wetland shrubs

Alder, *Alnus spp.*
Buttonbush, *Cephalanthus occidentalis*
Bog Rosemary, *Andromeda glaucophylla*
Dogwoods, *Cornus, spp.*
Leatherleaf, *Chamaedaphne calyculata*

3. Emergent vegetation

Cattails, *Typha spp.*
Pickerelweed, *Pontederia cordata*
Bulrushes, *Scirpus spp.*
Arrow Arum, *Peltandra virginica*
Arrowheads, *Sagittaria spp.*
Reed, *Phragmites cummunis*
Wild Rice, *Zizania aquatica*
Bur-reeds, *Sparganium spp.*
Purple loosestrife, *Lythrum salicaria*
Swamp-loosestrife, *Decodon verticillatus*
Water plantain, *Alisma plantage-aquatica*

4. Rooted, floating leaved vegetation

Water-Lily, *Nymphaea oderata*
Water Shield, *Brasenis schreberi*
Spatterdock, *Nuhar spp.*

5. Free-floating vegetation

Duckweed, *Lemna spp.*
Big Duckweed, *Spirodela polyrhizia*
Water Meal, *Wolffia spp.*

6. Wet meadow vegetation

Sedges, *Carex spp.*
Rushes, *Juncus spp.*
Cattails, *Typha spp.*
Rice Cut-Grass, *Leersia oryzoides*
Reed Canary Grass, *Phalaris arundinacea*
Swamp Loosestrife, *Decodon verticillatus*)

7. Bog mat vegetation

Sphagnum mosses, *Sphagnum spp.*
Bog Rosemary, *Andromeda glaucophylla*
Leatherleaf, *Chamedaphne calyculata*
Pitcher Plant, *Sarracenia purpurea*
Cranberry, *Vaccinium macro carpon*

8. Submerged vegetation

Pondweeds, *Potamogeton spp.*
Naiads, *Najas spp.*
Bladderworts, *Utricularia spp.*
Wild Celery, *Vallisneria americana*
Coontail, *Ceratophyllum demersum*
Water Milfoils, *Myriophyllum spp.*

APPENDIX 5

GRASSES FOR CONSERVATION IN THE NORTHEAST
USDA NATURAL RESOURCES CONSERVATION SERVICE

1. Tall Fescue, *Festuca arundinacea*

   (Kentucky 31 and Alta)

   A robust, long-lived, deep-rooted, bunchy grass often with short rhizomes. Useful for stabilization of waterways, slopes, banks, fills and spoils. Foliage is eaten by geese, deer, and cottontailed rabbits. The plant also provides nesting and fall winter cover for birds.

2. Reed Canarygrass, *Phalaris arundinacea* L.

   An excellent grass for stabilizing waterways, healing and controlling gullies, and protecting shorelines of ponds and reservoirs from wave action. Reed canarygrass is a long-lived clumpy perennial with coarse rhizomes.

3. Switchgrass, *Panicum virgatum*, L.

   Switchgrass is a valuable soil stabilization plant on strip-mine spoil. Switchgrass provides excellent nesting and fall winter cover, for pheasants, quail, and rabbits. It is sod forming, stiff stalked, and leafy.

4. Perennial Ryegrass, *Lolium perenne*

   A short-lived perennial, this bunchy grass grows from 1 to 2 feet tall. It is used extensively for erosion control, soil improvement, and cover crops.

5. Orchard Grass

   Common variety in the Northeastern States, is long-lived with dense, bunch type tufts. Used for soil improvements, silage, and erosion control.

6. Red Fescue, *Festuca rubia*

   An excellent soil binder, this variety is used extensively for stabilizing waterways, slopes, banks, cuts, and fills. Occurs in the creeping and bunch types, with the creeping red fescue spreading by short underground stems that form a tight, uniform sod. It is drought resistant, and adapts to both sandy and acid

soils. Creeping Red Fescue has been an outstanding soil finder in poorly drained areas.

7. Redtop, *Arostis alba*

A wide spread grass throughout the Northeast, this soil binder will grow under a wide variety of soil and moisture conditions. It seems no other grass will tolerate so great a variety of conditions as this grass.

8. Annual Lespedeza, *Lespedeza striate*

Another soil tolerant specie, this grass and its varieties will grow in soil testures ranging from sands to clays, and at fertility levels from low to high. Used for erosion control and general soil improvement, the Lespedezas also provide wildlife food.

9. Kentucky Bluegrass, *Poa pratensis*

This long-lived perennial grass forms a dense sod, and is used extensively for lawns, playgrounds, etc. It is also used for stabilizing waterways, slopes, banks, and fills. It is the most common pasture grass in the Northeast, providing food for ruffed grouse, turkeys, deer, and rabbits.

APPENDIX 6

FRESHWATER MANAGEMENT PONDS

The retention of adequate soil saturation within managed wetlands may prove difficult even with the use of management sills. Ponds (5 ft. + in depth) with controlled outlet elevations may prove useful for stabilizing wetland ground water elevations in adjoining wetlands.

The employment of open water ponding within wetlands has not been designated a primary best management practice because of the extensive land disturbance normally associated with pond excavation. Additionally, some regulatory agencies view the creation of new ponds in wetlands as a loss of wetland values and function. Nevertheless, the use of ponding to increase wetland habitat diversity should not be abandoned.

The creative use of open ponds within a wetland management plan is particularly appropriate in urbanizing areas where:

1. Pond excavation will require negligible wetland disturbance beyond the pond perimeter.

2. Soil and ground water conditions indicate that the pond water will help to maintain hydric soil saturation.

3. The pond will perform a "buffering" function upon urban stormwater runoff prior to its release into a wetland or waterway.

The most significant impact characterizing such "interface" areas is the repeated discharge of contaminant-laden stormwater into the wetland environment. Among the positive features of wetland management ponds near the wetland-upland boundary are:

1. Ready access to the upland would allow pond excavation and spoil haulage with little or no wetland disturbance beyond the pond edge and stormwater discharge culverts.

2. The pond can be situated on-line with shallow wetland management swales and stormwater discharge culverts.

3. The swales and pond are situated so as to absorb and dilute urban stormwater runoff contaminants prior to their entering waterways or wetlands.

Pond Design

A portion of the proposed pond should be shallow (approx. 1 ft.) in order to create an area of emergent wetland and to provide habitat for wading birds and wildfowl. The larger portion of the pond should be least 5 feet deep, however, in order to create stable fish habitat, and a volume of water capable of "buffering" the adverse impacts of urban stormwater contaminants.

Wetland ponds should be flexibly and creatively designed to affect water quality enhancement, while blending into the site vegetation and topography. The filtering or biochemical buffering capacity of an urban wetland pond is largely governed by its volume and the quality of water it receives from the upland. The following pond design and site parameters are suggested:

1. Pond size - approximately 1/8 acre or larger. (50' x 100")

2. Water depth - 4-5 ft. minimum, main body; 1+ ft. emergent vegetation area

3. Minimum tree removal

4. Retain buffer areas

5. Restore spoil haulage route and stabilize

6. Provide predaceous fish stocking within pond.

A properly designed and sited wetland "buffer" pond will also provide:

1. Increased adquate habitat diversity

2. Waterfowl resting or habitat area

3. Recreation use