HYDROLOGIC AND HABITAT MODIFICATION

NON POINT SOURCE
WATER POLLUTION

HYDROLOGIC AND HABITAT MODIFICATION MANAGEMENT PRACTICES CATALOGUE

FOR

NONPOINT SOURCE POLLUTION PREVENTION

AND

WATER QUALITY PROTECTION

IN

NEW YORK STATE

Prepared By:

Hydrologic and Habitat Modification Management Practices Sub-Committee of the New York State Nonpoint Source Management Practices Task Force

Summary Sheets Developed By:

NYS Department of Environmental Conservation
Division of Water
Bureau of Water Quality Management

AUGUST 1995

PREFACE

The Hydrologic and Habitat Modification Management Practices Catalogue was prepared by the New York State Department of Environmental Conservation, in cooperation with the agencies of the New York Nonpoint Source Coordinating Committee. Funds for this activity were provided by the U.S. Environmental Protection Agency-Region II under a Section 319 Grant of the Clean Water Act.

ACKNOWLEDGEMENTS

The following people generously donated their time and talent reviewing the Hydrologic and Habitat Modification Management Practice Summary Sheets:

Members of the Hydrologic and Habitat Modification Management Practices Subcommittee:

Steering Group:

- Doug Sheppard	NYSDEC, Division of Fish & Wildlife
- Ken Smith	NYS Department of State
- Tom Brewer	Hudson River-Black River Regulating District
- Rich Lewis	USDA - Natural Resources Conservation Service
- Kyle Williams	NYSDOT, Bureau of Environmental Analysis
- Mike Townsend	USDA - Natural Resources Conservation Service

Review Group:

- Robert Bode	NYSDEC, Biomonitoring Unit
- Ed Blackmer	NYSDEC, Dam Safety
- Richard Konsella	NYSDEC, Bureau of Flood Protection
- Daryl Caputo	Adirondack Hydroelectric Development Corporation
- David Fleury	Adirondack Park Agency
- Kenneth Kimball	Appalachian Mountain Club
- Robert Linck	New York Sea Grant Extension
- Keith McClintock	Westchester County SWCD and Planning Department
- Grady Moore	USGS - Water Resources Division
- Charles Morrison	NYSDEC, Land Resource Planning Office
- William Morton	NYSDEC, Bureau of Water Quality Management
- Chuck Nieder	NYSDEC, Hudson River Nat'l Estuary Research Reserve
- Susan McAlpine	Nature Conservancy
- Andy Zepp	Nature Conservancy
- Enid Sackin	NYC Department of Environmental Protection
- Ted Simroe	NYC Department of Environmental Protection
- Tom Sanford	Rensselaer County Soil & Water Conservation District
- Robin Ulmer	Boquet River Association
- Michael F. Walter	Cornell University - College of Agriculture and Life Sciences
- Margy Peet	Monroe County Water Quality Planning
- D. Muralidhar	NYSDEC, Bureau of Water Resources
- Michael Greason	NYSDEC, Division of Lands & Forests
- Olen J. Sharron	USDA - Consolidated Farm Services Agency

Others Who Provided Valuable Input:

- Robin Warrender	NYSDEC, Division of Water
- Diane Goetke	NYSDEC, Division of Fish & Wildlife
- Jack Isaacs	NYSDEC, Division of Fish & Wildlife

Thanks to Barbara J. Crier, Information Processing Specialist II, for the typing and formatting of this manual.

This manual was prepared and edited by Mr. Thomas H. Boekeloo, P.E., Environmental Engineer 2, Bureau of Water Quality Management, Division of Water, NYSDEC.

TABLE OF CONTENTS

HYDROLOGIC AND HABITAT MODIFICATION
MANAGEMENT PRACTICES
FOR
NONPOINT SOURCE POLLUTION PREVENTION
AND
WATER QUALITY PROTECTION
IN
NEW YORK STATE

I. INTRODUCTION

A. *Background*

The Water Quality Act of 1987 required states to prepare an Assessment Report identifying waterbodies affected by nonpoint source (NPS) pollution, to determine categories of significant NPS sources and to list state programs to control NPS pollution. States were also required to prepare a Management Program to deal with the source categories causing the major problems.

The New York State Department of Environmental Conservation (DEC) by virtue of its statutory authority for the management of water resources and control of water pollution in the state, has assumed the lead responsibility for control of NPS pollution in New York State. As part of this responsibility, DEC developed a Nonpoint Source Management Plan in January 1990. The Plan outlines how DEC will identify, describe and evaluate management practices to be used to control NPS pollution.

B. *Candidate Management Practices*

A list of candidate management practices was developed in 1989 by the Nonpoint Source Working Group, a task force under DEC leadership that is composed of federal and state agencies and groups representing a broad range of interests. The Group recognized that there are many ways to control nonpoint source pollution, but that the management practices were not systematically inventoried or evaluated for effectiveness in preventing or remediating nonpoint water quality problems in a statewide context. Also, they were not catalogued in a form that was convenient to users.

The Nonpoint Source Management Practice Task Force was created in early 1990 according to the guidelines contained in Chapter IV of the Nonpoint Source Assessment Report. Agencies listed in that chapter met in February of 1990 to set the process to be followed for establishing the list of management practices. Also, each agency identified source category sub-committees on which they wanted to participate.

C. *Hydrologic and Habitat Modification Management Practices Subcommittee*

In January 1995 two working groups representing different agencies were invited to serve on the Hydrologic and Habitat Modification Management Practices Sub-Committee. Under DEC leadership, these two groups were formed to address hydrologic and habitat modification as a source of nonpoint source pollution. The smaller steering group consisted of six members with expertise in streambank erosion control practices and flood control facilities. The larger review group consisted of twenty-three people who provided comments on the completed draft Management Practices Summary Sheets (MPSSs). Members of both groups within the Sub-Committee represented federal, state and local agencies, environmental or academic research institutions, and private sector utility industries.

The Subcommittee steering group was to identify and evaluate management practices for controlling nonpoint source pollution from streambank erosion and hydromodification of streams or reservoirs. The group assessed the preliminary list of candidate management practices, developed by NYSDEC staff, and enhanced or sometimes wrote practice descriptions and other sections of the draft MPSSs, and provided references.

D. *Hydromodification and Streambank Erosion as Sources of Pollution*

The 1993 Priority Water Problem List (PWP), published by the Division of Water's Bureaus of Monitoring and Assessment, and Water Quality Management, identified nearly 1,500 waterbody segments in New York State, comprising nearly 725,000 acres of surface freshwater and marine (bay and ocean) water, nearly 5,000 stream-miles, and almost 500 miles of Great Lakes shoreline that have been negatively affected by NPS pollution. Of these, hydrologic or habitat modification is the primary source of water quality problems and classified water use impairments on 56 waterbodies. They are caused by stream channelization, dredging, flow regulation or modification, removal of riprian vegetation, streambank modification and destabilization and surface water impoundments. Destructive or undesirable hydrologic or habitat modifications are not synonomous but do occur simultaneously. A related source of nonpoint source pollution is streambank erosion. Streambank erosion is the primary source of pollution in another 65 segments. An additional 233 segments are affected by either hydrologic or habitat modification or streambank erosion as a secondary source of pollution. One hundred eighty-two (182) segments are creeks or rivers and 51 are lakes, reservoirs, Great Lakes or bays.

A comparison of the segments affected by each pollutant source is shown in Table 1, (for primary sources only). The number of segments affected is shown in parenthesis.

Table 1
Comparison of Waterbody Impact from Hydrologic or Habitat Modification (HHM) versus Streambank Erosion (SBE)

Segment Type and Severity	Unit of Measure	Units Affected by HHM (# of Segments)	Units Affected by SBE (# of Segments)
Precluded:			
Rivers	Miles	16.8 (6)	1.0 (1)
Lakes	Acres	0 (0)	486 (1)
Lakes (Res.)	Acres	269 (1)	0 (0)
Impaired:			
Rivers	Miles	108.5 (12)	55 (7)
Lakes	Acres	34,327 (5)	0 (0)
Lakes (Res.)	Acres	7,165 (7)	0 (0)
Stressed:			
Rivers	Miles	122.2 (10)	458.4 (37)
Lakes	Acres	1,361 (4)	28 (30)
Lakes (Res.)	Acres	0 (0)	3 (10)
Threatened:			
Rivers	Miles	192 (11)	226.5 (14)
Lakes	Acres	0 (0)	5,000 (1)
Lakes (Res.)	Acres	0 (0)	0 (0)

As Table 1 shows, hydrologic and habitat modification affects fewer segments than streambank erosion but has a greater areal extent and greater severity. Figure 1 shows the geographical distribution with 17% in each of the Lake Erie/Niagara River Basin and Mohawk River Basin, followed by 13% in the Seneca-Oneida-Oswego Basin and 12% in the Upper Hudson Basin, and 10% in the Genesee Basin. The remainder are throughout the state.

Where hydrologic or habitat modification is the primary source, water level or flow alterations is the primary "pollutant" in 33 of 56 segments. Other pollutants were silt (sediment) in 13 segments, thermal changes in 8 segments and nutrients in 2 segments. In all 65 segments where streambank erosion was the primary source of pollutants, silt or sediment was the primary pollutant.

Sediment is a major pollutant in New York State. It destroys fish spawning areas, eliminates aquatic food sources, and causes gill abrasion. The flow capacity of natural channels is reduced, recreational values are compromised, and treatment costs of water supplies rise from increased sediment loads. In addition, nutrients and other pollutants may become attached to sediment particles and be transported to waterbodies by stormwater runoff.

Table 2 shows the breakdown of classified uses affected by each of this Catalogue's primary sources.

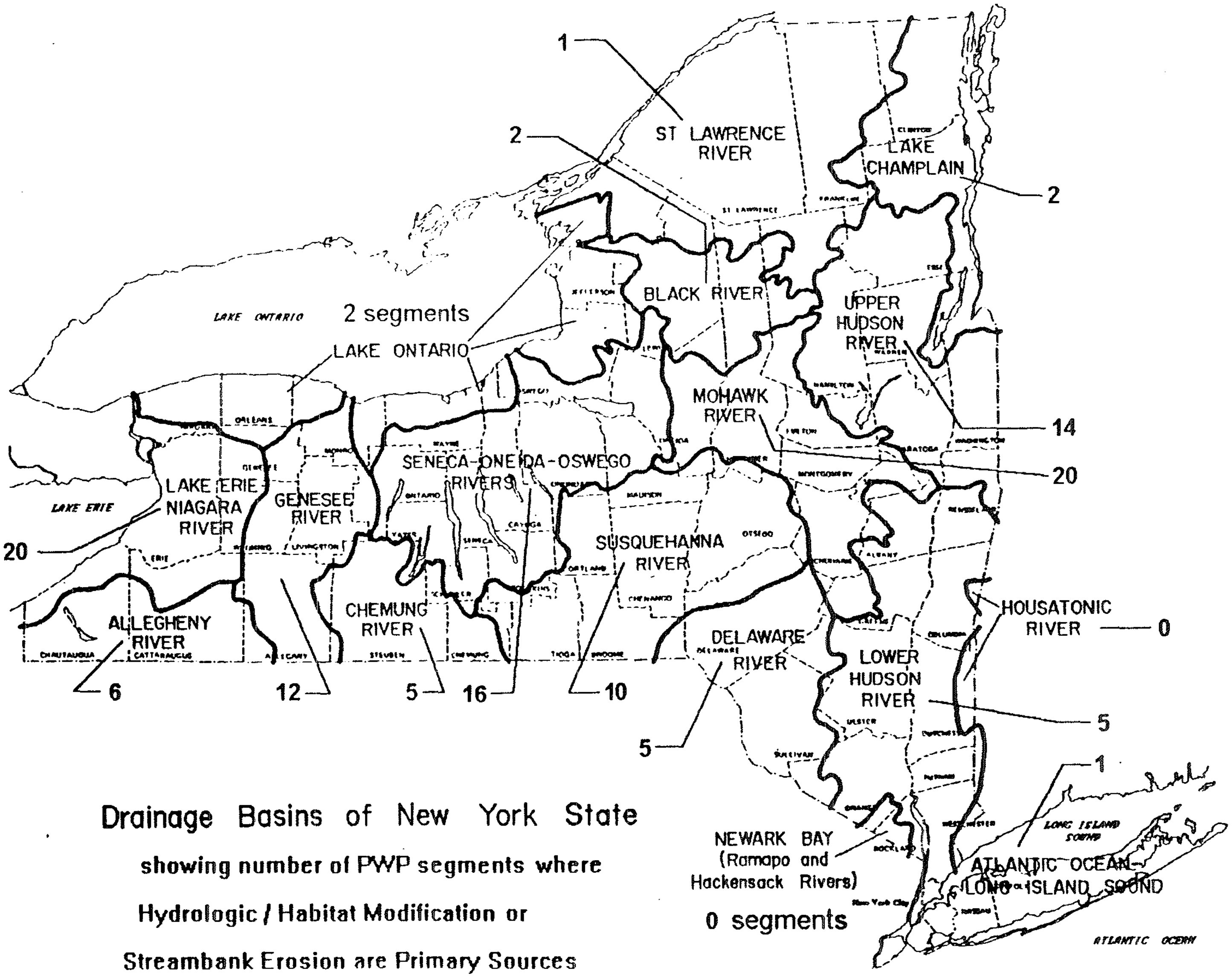
Table 2
Classified Uses Affected by Streambank Erosion and Hydrologic or Habitat Modification

Classified Use	Streambank Erosion - Affected Segments	Hydrologic Habitat Modification- Affected Segments
Water Supply	12	3
Bathing	8	5
Fish Propagation	29	29
Fishing	5	8
Fish Survival	5	10
Aesthetics	6	0
Boating	0	1

Environmental resources, including surface and groundwater, are protected from impacts from dams, channelization and flood control projects primarily through federal and state siting restrictions and permit conditions. Permits include those for freshwater wetlands, tidal wetlands, stream disturbance, and water quality certification. Operational procedures such as reservoir releases can be sources of hydrologic and habitat modification that are damaging to the classified use of the stream. Structural additions for fish passage and reservoir aeration facilities are positive or corrective hydrologic and habitat modifications.

HHM-4

Figure 1



Drainage Basins of New York State

showing number of PWP segments where

Hydrologic / Habitat Modification or

Streambank Erosion are Primary Sources

Two agricultural practices contribute to hydrologic and habitat modification: allowing livestock unrestricted access to streams and removal of riparian (stream corridor) vegetation. The first results in excess siltation and fertilization of streams and the second results in excessive temperature variations in streams and increased erosion and resulting siltation of streams. A parallel problem can occur in urban settings with unrestricted public access and removal of riparian vegetation.

E. *How to Use This Catalogue*

The Hydrologic and Habitat Modification Management Practices Catalogue is a reference document for those who develop or implement watershed protection or stream corridor management plans or provide educational or technical assistance to municipal officials, equipment operators, or organizers for volunteer service or sportsmen's groups. Nonpoint source pollution problems from various forms of streambank erosion and hydrologic modification projects are addressed by the practices in this Catalogue.

This Catalogue can be used during the preparation of a municipal or subdivision development or stream corridor management plan as a guide to selection of appropriate management practices for the control of NPS pollutants from eroding streambanks, scouring or filling flood control channels, excessively high or low flows from reservoir releases, or insufficiently circulating water impoundments. The Catalogue is not a design manual and should not be used to replace practice standards and specifications. Best management practices (BMPs) can be selected from the Catalogue based on the application of professional judgment to solve a particular NPS pollution problem in a specific location or to develop a maintenance plan. These practices whether used by private, commercial or governmental entities will generally diminish pollution from streambank erosion and hydrologic modifications and enhance habitat.

In many situations the services of a professional engineer-aquatic biologist team are needed to properly integrate the appropriate management practices with the environmental needs of the individual site and municipality. Management practices often include structural components that need to be installed, maintained and removed, if necessary, according to proper design. Office or on-site assistance with the design and layout of practices is often provided by the County Soil and Water Conservation District managers or technicians, USDA-Natural Resources Conservation Service (NRCS) engineers, or regional NYSDEC engineers or fisheries, or aquatic biologists.

This Catalogue contains two types of information that will help you select and implement hydrologic and habitat modification improvements:

1. **Management Practice Summary Sheets,** each of which describes a pollution control method, identifies the pollutants it controls, the circumstances under which the method should be used, positive and negative impacts on natural resources, other advantages and disadvantages, and costs;

2. **Appendices** - Some of the management and maintenance activities described in this catalogue require additional structural, vegetative or operational management practices for land uses upslope of the waterbody. For such cases, practices from other Catalogues are cross-referenced and listed in an appendix.

F. *Hydrologic and Habitat Modification Management Practice Summary Sheet Overview*

The following defines the terms used on the Management Practice Summary Sheets:

i.	**Title:**	name of the management practice as found at the top of the summary sheet.
ii.	**Definition:**	summary statement of the management practice.
iii.	**Water Quality Purpose:**	why the practice is used.
iv.	**Source Category:**	Hydrologic and Habitat Modification is the source category for all entries in this Catalogue.
v.	**Pollutants Controlled:**	NPS pollutants controlled by the management practice.
vi.	**Where Used:**	land uses or situations where the management practice can be applied.
vii.	**Practice Description:**	description of the management practice in terms of its vegetative, structural and/or operational components.
viii.	**Practice Effectiveness:**	summary, in either quantitative or qualitative terms, of the effectiveness of the management practice as documented by water quality monitoring and research findings. Practice effectiveness can vary widely according to watershed location, site conditions and other factors.
ix.	**Impact on Surface Water:**	possible impacts on water quality are defined as None (neutral), Beneficial (positive), Slight (negative), Moderate (negative), and Severe (negative).
x.	**Impact on Groundwater:**	possible impacts are defined as None (neutral), Beneficial (positive), Slight (negative), Moderate (negative), and Severe (negative).
xi.	**Advantages:**	address cost-effectiveness, additional practice benefits, and other tangible and intangible benefits.
xii.	**Disadvantages:**	projected unfavorable conditions associated with the management practice; they address economics, operations and maintenance, and expected problems.
xiii.	**Practice Lifespan:**	described in quantitative or qualitative terms.
xiv.	**Cost:**	estimated statewide average unit costs, system costs, or costs in qualitative terms.

xv. **Operation and Maintenance:** practical suggestions to help implement the operation and maintenance of the practice on an ongoing basis.

xvi. **Miscellaneous Comments:** regulatory requirements; additional management practices that are needed; availability of technical assistance or equipment, or other pertinent information.

xvii. **References:** references used to evaluate the management practice. including publications and university research. Management practice design standards and specifications are located in the references.

G. *Updating the Hydrologic and Habitat Modification Management Practices Catalogue*

The New York Nonpoint Source Coordinating Committee (NYNPSCC) is responsible for updating the Hydrologic and Habitat Modification Management Practices Catalogue. NYNPSCC meets quarterly but dedicates one meeting each year to consider updates to Management Practice Catalogues. NYNPSCC, which is composed of 17 member organizations and agencies, including DEC as the lead agency, will be responsible for:

* Reviewing proposed additions, deletions, and revisions to the Management Practices Catalogue.

* Identifying additional categories of nonpoint source pollution that have not been adequately addressed in the list of management practices.

* Suggesting research or demonstration projects on unproven or new management practices that appear to have potential for protecting water quality.

* Periodically reviewing the state list of management practices to verify the status of each practice. This review should be based on recently published literature and new or previously unknown research or demonstration projects.

H. *Conditions for Updating the Catalogue*

Any agency, organization, or group may propose an addition, deletion, or revision to the Catalogue, provided that the revision responds to one or more of the following conditions:

* Creation of a new management practice by an agency, university, or recognized group.

* Modification of an existing management practice, either in its design requirements or operation and maintenance.

* Emerging research data which indicates a change in management practice effectiveness and/or pollutants controlled

* Revisions in state or national water quality policy that necessitate a higher level of waterbody protection, resulting in higher management practice performance

standards. Policy revisions would result in additions or deletions of management practices or changes to existing summary sheets.

I. *How You Can Propose an Update of the Catalogue*

1. Submit proposed updates, im writing, by December 31 of each year to the New York Nonpoint Source Coordinating Committee, NYSDEC, Bureau of Water Quality Management, 50 Wolf Road, Albany, New York 12233-3508.

2. The Committee will review the proposed updates at their next regularly scheduled meeting. A subcommittee may be formed to study the proposed update and to request input from groups not represented on the Committee.

3. The subcommittee will review the proposed updates and determine if they meet the conditions above. In consultation with other interested groups, the subcommittee will make a recommendation to the Committee by May 1 of the following year.

4. When the proposed update is approved, The Committee will distribute copies of the additions or revisions, as approved, to all of its members and other holders of the set of Management Practices Catalogues.

J. *Do You Need a Permit?*

Implementing the management practices in this Catalogue may require one or more permits. A NYSDEC Joint Application for Permit(s) is available at all regional DEC Offices. The state permit programs likely to have jurisdiction over management practice implementation are as follows:

ARTICLE/SECTION	DESCRIPTION
Article 15, Title 5, ECL	Protection of Waters
Article 15, Title 27, ECL	Wild, Scenic and Recreational Rivers
Article 24, ECL	Freshwater Wetlands
Article 25, ECL	Tidal Wetlands
Article 34, ECL	Coastal Erosion
Article 36, ECL	Floodplain Management
Section 401, Federal Clean Water Act	Water Quality Certification (a federal program administered by NYSDEC)
Related Federal programs include:	
Section 10	River and Harbor Act of 1899 - for structures and work on navigable waters of the United States.
Section 103	Marine Protection, Research and Sanctuaries Act - for the transportation of dredged materials for dumping into ocean waters.

ARTICLE/SECTION	DESCRIPTION
Section 307	Coastal Consistency Certification - Coastal Zone Management Act of 1972 with amendments (a federal program administered by NYSDOS)
Section 404	Clean Water Act of 1977 - for disposal of dredged or fill material in waters of the United States.

The most likely minimum permit requirement will be an Article 15, Title 5 Protection of Waters Permit. Activities regulated by this program include disturbance of bed or banks of protected waters; construction and maintenance of dams; and excavation or filling in navigable waters. Further details can be found in the "Protection of Waters Program Applicants' Guide".

Activities conducted in and near freshwater wetlands that are regulated by Article 24 of the Environmental Conservation Law (ECL) generally include any that may adversely affect the wetland. More specific to the source category of hydrologic and habitat modification, regulated activities include construction of dikes and dams; placement of fill, excavation or grading; modification, expansion or extensive restoration of existing structures; drainage; and application of pesticides in wetlands. For more details, see the "Freshwater Wetlands Program Applicants' Guide".

Regulated activities in and near tidal wetlands are generally similar to those regulated under the Freshwater Wetlands Program (e.g., construction or reconstruction of structures such as weirs, groins, jetties, breakwaters, bulkheads, sea walls, retaining walls, rip-rap, gabions and drainage structures). Earth-moving activities regulated include dredge spoil placement, dune building, beach nourishment, clear-cutting and those listed under freshwater wetlands. Other details should be sought in the "Tidal Wetlands Program Applicants' Guide", or Article 25 of the ECL.

Regulated activities under the Wild, Scenic and Recreational River Systems Program are specific to the type of river system under construction (i.e., wild, scenic or recreational). Many are listed under programs above. Some added activities not previously mentioned are water withdrawals, stream improvement structures for fishing management purposes, fencing, public utility uses involving stream crossing or projects within 500 feet of stream bank, and vegetative cutting, thinning or other disturbance of vegetation. Further program details are in a separately published document on Part 666 of Title 6 of the New York Code of Rules and Regulations (NYCRR), or Article 15, Title 27 of the ECL.

Information on the other state and federal programs listed above and other regulated activities may be obtained from the Regional Permit Administrators or other Regulatory Affairs staff. For more complex projects, a pre-application conference may be arranged. For simpler projects, the landowner or the contractor will obtain a "Joint Application for Permit" and provide the application requirements which will include, but not be limited to, some or all of the following:

1. a detailed description of the activity.

2. a statement of the purpose of the activity.

3. a location map.

4. a list of the owners-of-record of land and water rights of the project sites and adjacent property.

5. detailed project plans.

6. recent, clear photographs of the site.

7. the application fee or fees.

8. information necessary for the State Environmental Quality Review Act and the State Historic Preservation Act.

9. for projects where the applicant is not also the owner, permission from the current landowner.

10. other information for DEC such as alternative plans or supplementary reports.

11. any information required for a variance.

12. major/minor project determination.

Beside the Department of Environmental Conservation permits and project review, other agencies may have jurisdiction over hydrology or habitat modifying management practices. The U.S. Army Corps of Engineers oversees federal permits. NYS Department of State reviews coastal projects, and provides consistency review for federal projects. NYS Office of General Services must be notified at:

NYS Office of General Services
Division of Land Utilization
Bureau of Land Management
Corning Tower, ESP
Albany, NY, 12242
(518/474-2195)

of projects involving underwater lands of New York State. Projects in the Adirondack Park may require permits from the:

Adirondack Park Agency
P.O. Box 99
Ray Brook, NY 12977
(518/891-4050)

And finally, local governments may have building permits, floodplain permits or other local requirements that must be met before a management practice from this Catalogue may be implemented or installed.

Permit Application Guides and published statutory authority and accompanying regulations may be obtained from NYSDEC Regional Permit Administrators.

HYDROLOGIC AND HABITAT MODIFICATION
MANAGEMENT PRACTICES

INDEX

MANAGEMENT PRACTICE SUMMARY SHEET

FLOOD CONTROL:
Modifying, Operating and Maintaining Flood Control Structures

DEFINITION

Design modifications, retrofit modifications, and structural or non-structural practices that can be used in addition to or instead of traditional flood control structures, designs or procedures for their operation or upkeep to improve nonpoint pollution control.

WATER QUALITY PURPOSE

To reduce the amount of nonpoint source pollutants being flushed into waterbodies due to high velocity, steep-walled, or channelized flood control structures.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment and the pollutants attached to it; thermal changes; and water level or flow alterations.

WHERE USED

Where upstream development exceeds or threatens to exceed the capacity of downstream flood control structures; where floodplains have been constricted, forcing increased stream velocity, bank scour or unstable banks; where aesthetics and wildlife diversity are as socially important as flood control.

PRACTICE DESCRIPTION

Using a comprehensive stream system plan, modifications in the designs, or changes in the operation and maintenance of flood control structures can be done to increase the roughness of the stream or modify the stream cross-section to reduce velocity and scour without reducing flood attenuation capacity or excessively increasing deposition: *in some instances geotextiles could be used in place of riprap or concrete channels; *interlocking concrete blocks with voids for vegetation and groundwater recharge provide an alternative to concrete channels; *urban stormwater facilities can retain floodwater volume permitting lower capacity, lower velocity channels or possibly natural streambeds and banks; *the use of multiple parallel levees, each set further away from the river, can provide greater flood control with the planting of trees between the first and second levees; *creating backwater channels or floodways in the floodplains maximizes the hydraulic capacity of the floodplain; *geotextile rolls can also decrease velocity while adding habitat value; and *constructing a low flow channel within the main channel or streambed will concentrate low summer flows and benefit instream fauna by allowing passage to deeper pools.

PRACTICE EFFECTIVENESS

*Grass alone can tolerate flows of 3 to 6 fps for up to 50 hours. *Geotextile mats tolerate flows of up to 14 fps for up to 50 hours. *Geotextiles come in various strengths, thicknesses and shapes, so effectiveness varies. *Effectiveness depends on how well sediment is prevented from entering the waterbody or being displaced at a destructive rate. *The effectiveness of improvements to retaining or diverting structures, under varying hydrologic events and for varying stream cross-sections and hydraulic characteristics, depends on a systematic watershed plan and proper selection and location of individual practice components.

IMPACT ON SURFACE WATER

Beneficial. Slower flows back up water, replenishing wetlands and restoring their flood attenuating function. The same happens in all floodplains, requiring development restrictions or some creative development within the floodplain.

IMPACT ON GROUNDWATER

Beneficial. Increased groundwater recharge; use of groundwater recharge as floodwater storage.

ADVANTAGES

*Incorporating vegetation and pervious materials can be less expensive than using only structural components. *More aesthetically pleasing. *Works with and accommodates natural stream (hydraulic) forces to improve habitat.

DISADVANTAGES

*May have limited applicability due to incompatability with the design of existing structures and cost of retrofitting. *Floodwater may wash away unestablished vegetation or vegetation/geotextile components.

PRACTICE LIFESPAN

Many of the bio-engineered designs using geotextiles have weathered 100-year storms, some sustaining no damage at all and others requiring minor repairs. Vegetation alone generally needs two or three growing seasons to become established enough to resist lower velocities of storms less intense than the 100-year storm.

COST

*Ranges from $10.00 or less per lineal foot for vegetative, earthen drainage and subsurface drainage work on mild slopes; to tens or hundreds of dollars per lineal foot on steep or high banks or simple structures on mild slopes; to hundreds of dollars per lineal foot for high-strength steel and concrete structures. *Also depends on the equipment and manpower required, the cost of disposal, if any. *Lining channels can be very expensive. *Practice components may be eligible for state or federal cost-sharing. Consult the county Soil and Water Conservation District for current programs.

OPERATION AND MAINTENANCE

All components should be inspected annually and after storms. Vegetated areas should be kept free of large woody plants with roots or weight that would threaten to undermine structural components or cause erosion if uprooted. Deficiencies should be noted and corrected before they become major problems.

MISCELLANEOUS COMMENTS

See ***MISCELLANEOUS COMMENTS*** on protected streams in the ***Streambank and Shoreline Protection*** summary sheet.

REFERENCES

Abt, S., C. Watson, and M. Peters. Colorado State University and J. Craig Fishenich, U.S. Army Corps of Engineers, Waterways Experiment Station. "Bank Stabilization and Habitat Aspects of Low-Flow Channels". January/February 1995. Vol. 39. Pg. 11.

Annandale, George W. "Scour: Erodibility, Resistance, and the Erosive Power of Water". Erosion Control. Vol. 2. No. 1. January/February 1995. Pg. 44.

Bader, Charles D. "The Many Approaches to Flood Control" Erosion Control. Vol. 2. No. 1. January/February 1995. Pg. 18.

Empire State Chapter, Soil and Water Conservation Society, New York Guidelines for Urban Erosion and Sediment Control. Syracuse, NY. October 1991.

Goldsmith, Wendi, Carol Franklin and Jose Alminana. "Healing Public Streambanks". Erosion Control. Vol. 1. No. 1. March/April 1994. Pg. 50.

Helfrich, L.A., et al., Virginia Cooperative Extension Service. Landowner's Guide to Managing Streams in the Eastern United States. Publication 420-141. Virginia Polytechnic Institute and State University. Blacksburg, Virginia. Reprinted September 1986.

McLaughlin, Dave. Monsanto. 800 N. Lindbergh Blvd. St. Louis, MO. "Tourist Town Reduces Flooding, Improves Aesthetics". Land and Water. January/February 1993. Vol. 37. Pg. 37.

Northcutt, Greg. :"Revegetation: Learning From Experience". Erosion Control. Vol. 1. No. 1. March/April 1994. Pg. 26

USDA - Soil Conservation Service. National Handbook of Conservation Practices. "Streambank and Shoreline Protection", February 1982; "Dike", October 1980; "Floodwater Diversion", "Floodway", October 1977; "Grade Stabilization Structure", "Stream Channel Stabilization", October 1977. **(Management Practice Design Standard and Specification)**

Whalen, Norman A., Project Officer. Nonpoint Source Control Guidance - Hydrologic Modifications. U.S. Environmental Protection Agency, Water Planning Division, Nonpoint Sources Branch, Washington, D.C. February 1977.

MANAGEMENT PRACTICE SUMMARY SHEET

FLOOD CONTROL:
Modifying, Operating and Maintaining Reservoirs

DEFINITION

Operational, vegetative and structural practices that can be used in the maintenance of reservoirs to reduce nonpoint source pollution.

WATER QUALITY PURPOSE

To improve water quality in the impoundment and downstream. Conformance with these management practices does not release dam owners from the requirement to apply for all necessary permits (see ***Miscellaneous Comments***).

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment, oxygen demand, water level/flow alteration, thermal changes and aesthetics.

WHERE USED

- Where large dams have release structures with multi-level intake devices, selective withdrawal can be used.
- Where deep reservoirs have low dissolved oxygen, artificial circulation for increasing dissolved oxygen can be used.
- At non-federal hydroelectric power dams where release schedules are part of the licensing process, minimum flows can be required and adjusted.
- Where impounded streams are in drainage basins large enough to have fisheries, minimum instream flow requirements can be used to benefit the fishery.

PRACTICE DESCRIPTION

The following lists hydrologic and habitat deficiencies at reservoirs, and the practices to mitigate those problems.

- Flow Modifications: comply with minimum instream flow agreements; release scouring flows when necessary to maintain sediment depths for habitat requirements.
- Water quality control: reservoir releases, selective withdrawal, improved turbine design, aeration devices, and re-regulation weirs all increase the dissolved oxygen levels of both reservoir and released waters.
- Channel design and maintenance: design or modification of the spillway to improve dissolved oxygen, or of the outlet channel to approximate hydraulic conditions of natural stream, thereby minimizing destructive turbulence.
- Fish Passage: various means, from a small jump to a large lift or ladder can be designed. Seasonal releases may be required.
- Erosion and Sediment Control: (see management practices in the **NYS Construction Management Practices Catalogue**). These practices should be used during construction of a new

dam as well as reconstruction of maintenance of existing dams or reservoirs.

- Spill Prevention and Control; Fuel and Waste Management: (see management practices in the **NYS Construction Management Practices Catalogue**). These practices should be followed in all reservoir watersheds.

PRACTICE EFFECTIVENESS

Artificial aeration of the hypolimnion (bottom water) can increase dissolved oxygen (D.O.) 1-4 mg/l. Spillway modifications (including weirs) can increase D.O. 3-6 mg/l. Flushing flows must be used with discretion as one of several stream maintenance activities.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUNDWATER

Slight.

ADVANTAGES

*Increased dissolved oxygen. *Improved habitat. *Control of sediment in stream channel.

DISADVANTAGES

*Less water is available for peak power requirements where minimum instream flows are required. *Often limited applicability due to the design of the control structures and expense of retrofitting.

PRACTICE LIFESPAN

Operational practice lifespans are indefinite. Structural practices vary from 10 to 25 years or more depending on design, materials and maintenance.

COST

Costs range from inexpensive for some operational measures to very expensive for some structural practices. Some examples are $60,000 for aeration wiers on the Guadaloupe River, TX, to $44 million for diffusers at 16 Tennessee Valley dams (both in 1990 dollars).

OPERATION AND MAINTENANCE

These retrofit structures and operational changes should be maintained as part of the dam or reservoir operation and maintenance schedule followed by the owner.

MISCELLANEOUS COMMENTS

*A NYSDEC permit is required if the dam: is at least 10 feet high; stores 1 million gallons (3.07 acre-feet); or has a drainage area (watershed) of one square mile. *The upland, upstream causes of reservoir eutrophication and resulting low dissolved oxygen in downstream releases should be addressed as the source of polluting sediments and nutrients to attain lasting water quality improvement.

REFERENCES

NYSDEC. Division of Water. An Owner's Guidance Manual for the Inspection and Maintenance of Dams in New York State. June 1987.

NYSDEC. Division of Water. Guidelines for Design of Dams. January 1985. (Revised: January 1989.)

USDA-SCS. National Handbook of Conservation Practices, "Multi-purpose Dams" and "Floodwater Retarding Dams". October 1977.

USEPA. Office of Water. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. Washington, DC. Pgs. 6-24 to 6-56. January 1993.

FLOOD CONTROL:
Proper Dam Breaching

DEFINITION

The partial or total dismantling of a water impounding structure.

WATER QUALITY PURPOSE

For beaver dams: To lower water levels so that nonpoint source generating land uses are not flooded. Examples: fertilized lawns or fields; on-site wastewater treatment systems and leachfields; any land use adjacent to shoreline or streambank.

For man-made dams: An "engineered" breach would be conducted to avoid an accidental breach. The water quality purpose is to avoid the environmental damage of a dam failure.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Nutrients, sediment, water level/flow, aesthetics, pathogens, unknown toxicity.

WHERE USED

Small, low hazard dams without an operable low-level outlet and beaver dams.

PRACTICE DESCRIPTION

Can range from removal of stop logs (removable boards that allow raising or lowering the spillway's elevation), to use of earth-moving equipment digging through the upstream side of the dam, to use of explosives to remove the dam or reduce the amount of water impounded by the dam. For NYS DEC permitted dams, see Guidelines for Design of Dams for policy on flash boards (boards installed on the spillway crest that are designed to fail in a flood to prevent dam overtopping).

PRACTICE EFFECTIVENESS

Gradual breaching is generally safer and more ecologically effective. The effectiveness of each breaching technique will depend on the site conditions.

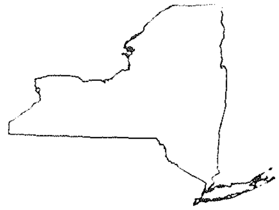
For beaver dam breaching, lasting effectiveness will depend on discouraging or defeating further beaver activity at the same site. Beaver tubes are sometimes installed to allow the beaver to maintain the dam while a corrugated metal culvert passes flow beneath the dam.

IMPACT ON SURFACE WATER	Beneficial.
IMPACT ON GROUNDWATER	None.
ADVANTAGES	*Relieves flooded conditions upstream. *Prevents further inundation of nonpoint source generating land uses.
DISADVANTAGES	*If breach is sudden, sediment previously trapped behind the dam will be released downstream. So use of explosives is generally discouraged.
PRACTICE LIFESPAN	This is either an emergency operational practice or demolition project used when stream conditions threaten to cause dam failure or, in the case of beaver dams, when flooding becomes a nuisance through excessive streambank or shoreline erosion or threatening property damage.
COST	Varies with size of the dam, accessibility to the site, site and ground conditions and type of breaching technique selected.
OPERATION AND MAINTENANCE	Work area should be isolated to reduce and contain sediment released and generated. When practice is complete stream flow should be returned to normal flow for the channel cross-section and grade. Sediment should be deposited in an upland area, in a sediment basin or according to permit conditions.
MISCELLANEOUS COMMENTS	•Dams old enough to require breaching may be holding a significant amount of sediment which would be released if dam is breached improperly. Sediment may be clogging low-level outlets in old dams. •Improper breaching leading to total and sudden failure could leave dam owner open to civil or possibly criminal liability. •Permits are required for removal or breaching of dams. •For beaver dams Article 11, Title 5 "Interference with Fish and Wildlife", Article 15; Title 5 "Protection of Waters" , 6NYCRR 608 "Water Quality Certification", and Article 24 "Freshwater Wetland" permits are needed. In the Adirondack Park, call or write the Adirondack Park Agency for permit requirements and conditions. No federal permits are required. •For man-made dams one or more of the same permits will also be required depending on the site. •A professional engineer should be retained to design and oversee man-made dam breaching or removal. •Proper design, construction, operation and maintenance of dams should be pursued to avoid accidental breaching of man-made dams. •By-pass ponds as an alternative to dams would avoid the need to breach dams.

REFERENCES

NYSDEC. Division of Water. Bureau of Flood Protection. Dam Safety Section. Guidelines for Design of Dams. January 1985. Revised January 1989. Pgs. 12-15.

NYSDEC. Division of Water. Bureau of Flood Protection. Dam Safety Section. An Owners Guidance Manual for the Inspection and Maintenance of Dams in New York State. June, 1987. Chapter 8. "Emergency Action Plan Guidelines".



MANAGEMENT PRACTICE SUMMARY SHEET

STREAMBANK AND SHORELINE PROTECTION

DEFINITION

The use of vegetation, structures, biotechnology, or management techniques to stabilize and protect streambanks and shorelines.

WATER QUALITY PURPOSE

To reduce sediment and nutrients entering waterbodies from eroding streambanks and shorelines.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Primarily sediment and solid-phase nutrients. Individual practices may also control water level or flow, toxics, oil and grease, pathogens, oxygen demand, thermal changes, and debris.

WHERE USED

Streambanks, lake shores, estuaries and coastal shorelines.

PRACTICE DESCRIPTION

Streambank and shoreline protection involves the following components: (1) vegetation (rushes, sedges, grasses, legumes, shrubs or trees), (2) structural improvements (slope stabilization, filter fabric, riprap, deflectors, fencing, bulkheads, or groin systems), (NOTE: National Handbook of Conservation Practices is not applicable for structures higher than 3' above mean high water. See ***Coastal Shore Protection*** summary sheet for large lake and ocean front erosion control practices.) (3) management techniques (removing debris, fallen trees, or gravel bars in the flood plain on the inside curves of the stream) (see ***Selective Clearing and Snagging*** summary sheet), and (4) biotechnical alternatives (the use of willow wattles or direct seeding)

PRACTICE EFFECTIVENESS

The effectiveness of streambank and shoreline protection should be evaluated based on the component practices installed. In general, the practice will decrease the flow and bed load of the stream, reduce soil erosion, and decrease sediment and nutrient delivery to waterbodies.

IMPACT ON SURFACE WATER

In general, impacts range from beneficial to slight, depending upon design or component selected.

IMPACT ON GROUNDWATER

None.

ADVANTAGES

*Vegetatively stabilized streambanks & shorelines can provide wildlife cover. *Some sites can provide fishing access to anglers. *Vegetative treatments may have secondary benefits for their pollutant-filtering ability. *Mature woody vegetation lowers stream temperatures by shading stream segments, improving fishery habitat. *Stabilized areas reduced sediment entering waterbodies, thereby reducing downstream flooding hazards, and the need for dredging.

DISADVANTAGES

*Installation of practice components may result in a temporary increase of sediment and nutrients delivered to the stream during construction. *This practice may result in a temporary loss of wildlife habitat during implementation of the practice.

PRACTICE LIFESPAN

Ranges from 5 years to over 25 years, depending upon component selected.

COST

Low for vegetative and some bio-technical methods. High for structural designs. Thermal degradation may offset costs of rip-rap. Some component practices may be eligible for state and federal cost-sharing; contact the county Soil and Water Conservation District manager for current programs.

OPERATION AND MAINTENANCE

Varies with design or component selected. Debris should be removed from the stabilized streambank or shoreline. Structural practices should be inspected after storm events. Vegetation destroyed by bank failure must be replaced to maintain cover integrity.

MISCELLANEOUS COMMENTS

All parties are alerted to the legal requirements affecting protected streams. Individuals wishing to undertake streambank and shoreline protection work that could disturb a protected stream are required to obtain an Article 15-Protection of Waters Permit from their Regional Office of the Department of Environmental Conservation. The Regional Office can tell you if the stream segment to be affected is on the protected list. The Regional Office also can advise you whether or not other permits may be required; for example, Article 24-Freshwater Wetlands Permits; Article 34-Coastal Erosion Permits; Article 25-Tidal Wetlands Permits; Article 36-Floodplain Permits (whether administered by local government or DEC); as well as possible requirements for work proposed along a stream or river protected under the Wild, Scenic and Recreational Rivers Act. The Regional DEC Office will advise you of Section 404, Section 401 and Section 10 federal permits which might be required. By becoming a "party-in-interest", the public has the opportunity to review and comment, and thus to influence the issuance of permits under the above programs.

REFERENCES

Empire State Chapter, Soil and Water Conservation Society, New York Guidelines for Erosion and Sediment Controls. Syracuse, NY. March, 1989.

NYS Department of Environmental Conservation. Longabucco, P., Controlling Agricultural Nonpoint Source Water Pollution in New York State: A Guide to the Selection of Best Management Practices to Improve and Protect Water Quality, Albany, NY. 1991.

U.S. Army Corps of Engineers. Low Cost Shoreline Protection. Washington, DC. 1981.

U.S. Army Corps of Engineers. Streambank Protection Guidelines. Washington, DC. October, 1983.

USDA. Soil Conservation Service. Effects of Conservation Practices on Water Quantity and Quality. Washington, DC. October 1988.

USDA. Soil Conservation Service. National Handbook of Conservation Practices. "Streambank and Shoreline Protection". Syracuse, NY. February 1982. **(Management Design Standard and Specification)**

USDA. Soil Conservation Service. Guide to Conservation Plantings on Critical Areas. Syracuse, NY.

STREAMBANK AND SHORELINE PROTECTION: Biotechnical Methods

DEFINITION

The use of live dormant stem cuttings or plants in combination with geotextiles or structural devices for erosion control.

WATER QUALITY PURPOSE

Reduction of sediment scouring from bank and bed; sediment trapping; thermal moderation (stream cooling in summer); increased dissolved oxygen and nutrient uptake.

SOURCE CATEGORY

Hydrologic and Habitat Modification

POLLUTANTS CONTROLLED

Sediment, nutrients, pathogens and toxics.

WHERE USED

*Live stakes: use along meandering streams having fairly stable streambanks with moderate slopes (4:1 or less) and little active scouring. *Live fascines (defined in ***Practice Description)***: use where scour causes streambank washout and where water level fluctuation is moderate. *Branch packings: where scouring has washed out areas no larger than twelve feet long, five feet wide or four feet deep and where the current is fast. *Live cribwall: main channels with strong current; and to prevent channels from splitting.

PRACTICE DESCRIPTION

*Live stakes are dormant woody plant cuttings that root quickly and are large enough to be tamped into the streambed or bank as stakes. *Live fascines are bundles of live cuttings tied together and secured in trenches parallel to the streambank. *Branch packings are alternating layers of live branches and soil. *Live cribwalls are layers of rock and plant cuttings within a log frame or crib. *Plant butt end down for stakes; at right angles to the streambank with branch tips twelve inches higher for branch packings or cribwalls; and parallel to the stream for fascines. *Forty to fifty percent of stakes should be below ground level after planting; fascines are buried (except tips) in a series of five shallow trenches; dormant branches in packings and cribs are layered with soil and gravel.

See ***REFERENCES*** for further specifications.

PRACTICE EFFECTIVENESS

Effectiveness depends on intensity of flooding, scouring, undercutting, and destructive power of ice floes. Live stakes provide effective stabilization, and erosion control once established; live fascines provide immediate erosion protection and sediment collection; branch packings provide immediate protection from fast currents and a very effective means of revegetating a scoured streambank; live cribwalls are very effective at controlling bank erosion on fast flowing streams.

IMPACT ON SURFACE WATER

All: Beneficial.

IMPACT ON GROUNDWATER

All: None.

ADVANTAGES

*Biotechnical practices are generally less costly than structural and become a permanent, natural part of the streambank. *Live stakes are a quickly installed method, and inexpensive if cuttings are locally available; live fascines are durable before cuttings have rooted, and economical where materials or pre-assembled fascines are locally available; for branch packings cuttings are normally available locally; live cribwalls provide immediate protection as the plants become permanently established.

DISADVANTAGES

*Installation of all these methods should be between November and March. Live stakes: subject to damage or failure due to flooding or low water levels. *Live fascines: requires hand planting; must plant in dormant season (November to March); requires plant species with narrowly spreading branches. *Branch packings: large amounts of branches and manual labor required. *Live cribwall: depends on local availability of logs and greater construction knowledge and ability.

PRACTICE LIFESPAN

If plantings survive first two or three years, lifespan is indefinite and only subject to natural succession.

COST

About $10.00 per foot bank plus the cost of bank preparation of necessary. May be eligible for state or federal cost-sharing.

OPERATION AND MAINTENANCE

Inspect plantings frequently especially during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible.

MISCELLANEOUS COMMENTS

*Select healthy native cuttings while in dormant stage. Native tree species that root readily from stem cuttings should be used. Selected stock materials must be free if diseases and from vigorous plant stock. *Stakes should be planted a minimum of 2 feet below water level; fascines started at the mean low water line; branch packings started below the waterline; and cribs started 2-3 feet below the streambed. *It is best to cut the same day as planting. Otherwise, cut material should be kept submerged in water up to the time of planting. *Stream disturbance permit required (see ***Streambank and Shoreline Protection*** summary sheet).

REFERENCES

Jones, D. and M. Battaglia. A Streambank Stabilization and Management Guide for Pennsylvania Landowners. Department of Environmental Resources. Office of Resources Management. Harrisburg, PA, 1986.

Selected notes: USDA/SCS Illinois. "Standards and Specs for Use of Dormant Woody Plantings for Streambank Protection".

Selected notes from "The Court Creek Restoration Project", from International Erosion Control Association Conference Proceedings. February 1990. Washington, D.C. By: Donald Roseboom (IL State Water Survey) and Bill White (IL Department of Conservation).

USDA-Soil Conservation Service. A Guide to Conservation Plantings on Critical Areas for New York. Plant Materials Technical Reference #11. June 1991. Syracuse, NY.

USDA-Soil Conservation Service. Engineering Field Handbook, Ch. 18. "Soil Bioengineering for Upland Slope Protection". 1992.

"Willow Post Project Update". Boquet River Association (BRASS) Newsletter. September, 1994. Elizabethtown, NY.

"Whallonsburg Black Willow Project" Boquet River Association (BRASS) Newsletter. June, 1994. Elizabethtown, NY.

MANAGEMENT PRACTICE SUMMARY SHEET

STREAMBANK AND SHORELINE PROTECTION:
Coastal Shore Protection

DEFINITION	Structural and non-structural means of minimizing the erosion of oceanfront and large lakefront bluffs, dunes, beaches and wetlands.
WATER QUALITY PURPOSE	To prevent nearshore nonpoint pollution problems of eroded sediment and pollutants from sloughed, eroded land uses (e.g., building debris, septic systems, dumps, landfills, petroleum or chemical storage).
SOURCE CATEGORY	Hydrologic and Habitat Modification.
POLLUTANTS CONTROLLED	Sediment, toxic substances, pathogens, nutrients, oil and grease, construction and demolition debris.
WHERE USED	Where runoff from the top of a bluff is cutting into the bluff as rills and gullies; where groundwater is seeping through the bluff threatening or causing sloughing; where the greenbelt has been removed from the bluff or shoreline; where excessive weight (e.g.: buildings) is located near the edge of the bluff; where erosion (shoreline recession) has left structures and improvements exposed to direct inundation and wave attack.
PRACTICE DESCRIPTION	The combined or individual use of either non-structural practices such as relocation of structures, preservation or establishment of vegetation, grading, earthen drainage control and subsurface drainage control; or structural practices such as stone revetments, gabion basket revetments, or retaining walls (i.e., rock-filled timber cribs, timber walls, steel bulkheads, or reinforced concrete) protected by splash aprons and toe protection.
PRACTICE EFFECTIVENESS	Depends on proper selection of "design wave" and appropriate design parameters; establishment of vegetation along the new top-of-bank or shore-side of the structure; and the integrity of construction, especially the toe protection.
IMPACT ON SURFACE WATER	Beneficial to moderate. Inappropriately placed structures could increase erosion downdrift on adjacent beaches and wetlands.
IMPACT ON GROUNDWATER	None to moderate. Draining groundwater lowers the groundwater table.
ADVANTAGES	*Prevents or substantially delays erosion of bluff, beach or wetland and possible loss of previously stable uplands.
DISADVANTAGES	Structural devices to control erosion at one site can facilitate erosion at an adjacent location. In the case of bulkheads and seawalls, splash aprons and toe protection will reduce erosion immediately seaward of the protecting structures.

PRACTICE LIFESPAN

Due to unpredictable strength and frequency of waves, the lifespan is highly variable. A piece-meal rather than holistic design will likely reduce the lifespan of any practice. Structural installations should have design lifespans of 25 years or more with proper maintenance throughout the life of the structure.

COST

Range from $10.00 or less per lineal foot for vegetative, earthen drainage and subsurface drainage work on mild slopes; to tens or hundreds of dollars per lineal foot on steep or high banks or simple structures on mild slopes; to hundreds of dollars per lineal foot for high-strength steel and concrete structures. Relocation of homes is in the tens of thousands of dollars. Coastal shoreline protection requires the hiring of a professional engineer for all but the most minor vegetation or earthen runoff diversion projects. Municipal projects for flood protection and coastal shore protection (including the Great Lakes shoreline) may be eligible for State and/or federal cost sharing. Contact the Regional DEC Floodplain Management Coordinator for more information on State and federal assistance.

OPERATION AND MAINTENANCE

All components should be inspected annually and after storms. Vegetated areas should be kept free of large woody plants with roots or weight that would threaten to undermine structural components or cause erosion if uprooted. Offshore waters should be cleared of large debris that might undermine toe protection.

MISCELLANEOUS COMMENTS

For permit requirements, see ***Streambank and Shoreline Protection (General)*** summary sheet.

REFERENCES

Empire State Chapter. Soil and Water Conservation Society. New York Guidelines for Urban Erosion and Sediment Control. Syracuse, NY. October 1991.

McComas, Steve. Blue Water Science. Lake Smarts: The First Lake Maintenance Handbook. Terrene Institute and U.S. Environmental Protection Agency. Washington, DC. November 1993.

St. Lawrence-Eastern Ontario Commission - Shoreline Erosion Control. 1980.

U.S. Army Corps of Engineers. Low Cost Shore Protection. Prepared by Rogers, Golden And Halpern, Inc., Philadelphia, PA. 1981.

USDA - Soil Conservation Service. Guide to Conservation Plantings on Critical Areas. Syracuse, NY. June 1991.

USDA - Soil Conservation Service. National Handbook of Conservation Practices. "Streambank and Shoreline Protection", February 1982; December 1990. (Note: Not applicable for structures higher than 3 feet above mean high tide or mean high water.)

STREAMBANK AND SHORELINE PROTECTION:
Controlling Instream Sediment

DEFINITION

Preventing the introduction of sediment into the stream and limiting the disturbance of construction activities conducted in the stream channel.

WATER QUALITY PURPOSE

To limit the destructive effects of sediment in the stream to aesthetics and to the classified uses of the stream: water supply, fishing, fish survival, fish propagation, and swimming.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment.

WHERE USED

Primarily at stream crossings for logging roads, access roads, bridges, and rights-of-way for utility pipeline crossings (at both temporary and permanent crossings), and at dredging or resource extraction (gravel) sites.

PRACTICE DESCRIPTION

Isolation of the work area and collecting or trapping, the sediment for on-site incorporation into streambank stabilization or disposal outside the streambank. This can be done with sediment mats (trademark) or coffer dams on stream diversions or turbidity curtains (see **Construction Management Practices Catalogue** for a description of the turbidity curtain, sediment mat, temporary sediment trap and temporary sediment basin m and water course crossing). Boring under the stream is another alternative.

PRACTICE EFFECTIVENESS

If practices are constructed and operated correctly removal efficiencies range between 80% and 90%. Timing of construction activities, proper diversion of flow and weather forecast awareness can be critical to the effectiveness of these practices. Boring under the stream keeps most sediment out of the stream.

IMPACT ON SURFACE WATER

Beneficial. Hydrologic and habitat modifications are both minimized. Boring has minimal impact on surface water.

IMPACT ON GROUNDWATER

None.

ADVANTAGES

*Reduces nutrients and toxics entering streams attached to sediment particles. *Reduces need for dredging. *Protects instream habitat from being smothered or scoured away. *Boring under the streambed minimizes stream disturbances.

DISADVANTAGES

Turbidity curtains are ineffective in a heavy current. Boring or directional drilling may require a wider staging area than that of a typical pipeline construction right-of-way.

PRACTICE LIFESPAN

These are temporary practices used for the duration of the instream construction project.

COST

See Construction Catalogue for turbidity curtains, temporary sediment trap, temporary sediment basin, temporary water crossing and sediment mat costs. Coffer dam, stream diversion, and boring costs increase with stream width. Cost of boring also increases with amount of bedrock to penetrate.

OPERATION AND MAINTENANCE

Varies according to practices selected. Repair damage to devices; monitor for short-circuiting or leaks; remove accumulated sediment.

MISCELLANEOUS COMMENTS

For permit requirements, see ***Streambank and Shoreline Protection (General*** summary sheet.

REFERENCES

Empire State Chapter. Soil and Water Conservation Society. New York Guidelines for Erosion and Sediment Controls. Syracuse, NY. October 1991.

Fifield, Jerald S., Ph.D. Hydrodynamics, Inc. "What is Required for Effective Sediment Control?" Land and Water. March/April 1994. Pgs. 38-40.

NYS Department of Environmental Conservation. Morton, W. Stream Corridor Management: A Basic Reference Manual. Albany, NY. January 1986.

NYS Department of Transportation. Highway Design Manual. December 1986.

NYS Department of Transportation. Standard Specifications. January 1990. **(Management Practice Design Standard and Specification)**

Peterson, Allen. Section Environmental Specialist. New York State Electric and Gas Corporation. "Controlling Sediment in Streams and Waterways". Land and Water. March/April 1994. Pgs. 35-38.

STREAMBANK AND SHORELINE PROTECTION: Geotextiles

DEFINITION

Synthetic and natural materials usually in the shape of nets, mats or blankets used to assist the establishment of vegetation or placement of riprap.

WATER QUALITY PURPOSE

To minimize erosion degrading surface waters.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment directly. Indirectly enhances the temperature-modifying and nutrient-absorbing effect of vegetation by holding soil and water.

WHERE USED

Various grades of geotextiles are used in increasingly erosive environments:

- Where vegetation needs protection from wind or water erosion.
- Where mulches need anchoring (slopes).
- Where a higher strength reinforcement than mulch is needed to hold sod or plantings on a site using bioengineering.
- In place of or under riprap (durable, angular and well-graded stone).

PRACTICE DESCRIPTION

Recent classification by product performance has been conducted by the Erosion Control Technology Council (ECTC):

- Low-Velocity Degradable RECPs (Rolled Erosion Control Products) - single-net, organic fiber erosion control blankets used on slopes of moderate length grade with moderate runoff.
- High-Velocity Degradable RECPs - double or high-strength-net made of multiple fibers or higher strength fibers used on steeper slopes of greater runoff quantity and velocity but where natural vegetation is expected to succeed as permanent soil stabilization.
- Long-Term Non-Degradable RECPs - geosynthetic mattings of high tensile strength used for critical area applications requiring immediate and continuing high-performance erosion control.

PRACTICE EFFECTIVENESS	More effective than vegetation alone, but no quantitative data available at this time. Product performance standards are in the development stage. Generally, their effectiveness on slopes is better and longer lasting than conventional loose mulching, tackifiers or hydraulic mulching. Effectiveness is determined primarily by matching the correct product to the site conditions and anticipated or historical erosive forces.
IMPACT ON SURFACE WATER	Beneficial. Aids soil structure in resisting erosive force of runoff.
IMPACT ON GROUNDWATER	None.
ADVANTAGES	*Lighter, less costly than structural improvements. *Immediately stronger than vegetative stabilization. *Longer lived than vegetative stabilization.
DISADVANTAGES	More expensive than vegetation alone.
PRACTICE LIFESPAN	• Low-Velocity Degradable RECPs: one to two growing seasons. • High-Velocity Degradable RECPs: One to five years, functionally. • Long-Term Non-Degradable RECPs: No long-term information.
COST	See Buyers Guide in November/December 1994 issue of Land and Water. Varies with material strength and lifespan. Materials include coconut (coir) fiber, polyethylene, polyester, jute (glossy fiber of one of two East Indian plants), geosynthetics and photodegradable geosynthetics.
OPERATION AND MAINTENANCE	Inspect installation annually and after storms or floods.
MISCELLANEOUS COMMENTS	USEPA requirements for products to contain as much recovered material as practical could affect prices and performance standardization.

REFERENCES

"1995 Buyers Guide". Land and Water. Vol. 38. November/December 1994. Land and Water, Inc. Fort Dodge, IA.

Austin, Deron N. and Toney Driver. "Classifying Rolled Erosion Control Products". In Erosion Control, Journal of the International Erosion Control Association, January/February 1995. Pgs. 48-53.

"Government Buying Guidelines Could Hurt Geotextile Industry". In Erosion Control, Journal of the International Erosion Control Association. January/February 1995. Pgs. 13-14.

Theisen, Marc S. "The Expanding Role of Geosynthetics in Erosion and Sediment Control". Land and Water. Vol. 36. November/December 1992. Land and Water, Inc. Ft. Dodge, IA.

Theisen, Marc S. "The Expanding Role of Geosynthetics in Erosion and Sediment Control". Land and Water. Vol. 37. January/February 1993. Land and Water, Inc. Ft. Dodge, IA.

STREAMBANK AND SHORELINE PROTECTION: Coastal Shore Protection

DEFINITION	Structural and non-structural means of minimizing the erosion of oceanfront and large lakefront bluffs, dunes, beaches and wetlands.
WATER QUALITY PURPOSE	To prevent nearshore nonpoint pollution problems of eroded sediment and pollutants from sloughed, eroded land uses (e.g., building debris, septic systems, dumps, landfills, petroleum or chemical storage).
SOURCE CATEGORY	Hydrologic and Habitat Modification.
POLLUTANTS CONTROLLED	Sediment, toxic substances, pathogens, nutrients, oil and grease, construction and demolition debris.
WHERE USED	Where runoff from the top of a bluff is cutting into the bluff as rills and gullies; where groundwater is seeping through the bluff threatening or causing sloughing; where the greenbelt has been removed from the bluff or shoreline; where excessive weight (e.g.: buildings) is located near the edge of the bluff; where erosion (shoreline recession) has left structures and improvements exposed to direct inundation and wave attack.
PRACTICE DESCRIPTION	The combined or individual use of either non-structural practices such as relocation of structures, preservation or establishment of vegetation, grading, earthen drainage control and subsurface drainage control; or structural practices such as stone revetments, gabion basket revetments, or retaining walls (i.e., rock-filled timber cribs, timber walls, steel bulkheads, or reinforced concrete) protected by splash aprons and toe protection.
PRACTICE EFFECTIVENESS	Depends on proper selection of "design wave" and appropriate design parameters; establishment of vegetation along the new top-of-bank or shore-side of the structure; and the integrity of construction, especially the toe protection.
IMPACT ON SURFACE WATER	Beneficial to moderate. Inappropriately placed structures could increase erosion downdrift on adjacent beaches and wetlands.
IMPACT ON GROUNDWATER	None to moderate. Draining groundwater lowers the groundwater table.
ADVANTAGES	*Prevents or substantially delays erosion of bluff, beach or wetland and possible loss of previously stable uplands.
DISADVANTAGES	Structural devices to control erosion at one site can facilitate erosion at an adjacent location. In the case of bulkheads and seawalls, splash aprons and toe protection will reduce erosion immediately seaward of the protecting structures.

PRACTICE LIFESPAN

Due to unpredictable strength and frequency of waves, the lifespan is highly variable. A piece-meal rather than holistic design will likely reduce the lifespan of any practice. Structural installations should have design lifespans of 25 years or more with proper maintenance throughout the life of the structure.

COST

Range from $10.00 or less per lineal foot for vegetative, earthen drainage and subsurface drainage work on mild slopes; to tens or hundreds of dollars per lineal foot on steep or high banks or simple structures on mild slopes; to hundreds of dollars per lineal foot for high-strength steel and concrete structures. Relocation of homes is in the tens of thousands of dollars. Coastal shoreline protection requires the hiring of a professional engineer for all but the most minor vegetation or earthen runoff diversion projects. Municipal projects for flood protection and coastal shore protection (including the Great Lakes shoreline) may be eligible for State and/or federal cost sharing. Contact the Regional DEC Floodplain Management Coordinator for more information on State and federal assistance.

OPERATION AND MAINTENANCE

All components should be inspected annually and after storms. Vegetated areas should be kept free of large woody plants with roots or weight that would threaten to undermine structural components or cause erosion if uprooted. Offshore waters should be cleared of large debris that might undermine toe protection.

MISCELLANEOUS COMMENTS

For permit requirements, see ***Streambank and Shoreline Protection (General)*** summary sheet.

REFERENCES

Empire State Chapter. Soil and Water Conservation Society. New York Guidelines for Urban Erosion and Sediment Control. Syracuse, NY. October 1991.

McComas, Steve. Blue Water Science. Lake Smarts: The First Lake Maintenance Handbook. Terrene Institute and U.S. Environmental Protection Agency. Washington, DC. November 1993.

St. Lawrence-Eastern Ontario Commission - Shoreline Erosion Control. 1980.

U.S. Army Corps of Engineers. Low Cost Shore Protection. Prepared by Rogers, Golden And Halpern, Inc., Philadelphia, PA. 1981.

USDA - Soil Conservation Service. Guide to Conservation Plantings on Critical Areas. Syracuse, NY. June 1991.

USDA - Soil Conservation Service. National Handbook of Conservation Practices. "Streambank and Shoreline Protection", February 1982; December 1990. (Note: Not applicable for structures higher than 3 feet above mean high tide or mean high water.)

MANAGEMENT PRACTICE SUMMARY SHEET

STREAMBANK AND SHORELINE PROTECTION:
Controlling Instream Sediment

DEFINITION

Preventing the introduction of sediment into the stream and limiting the disturbance of construction activities conducted in the stream channel.

WATER QUALITY PURPOSE

To limit the destructive effects of sediment in the stream to aesthetics and to the classified uses of the stream: water supply, fishing, fish survival, fish propagation, and swimming.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment.

WHERE USED

Primarily at stream crossings for logging roads, access roads, bridges, and rights-of-way for utility pipeline crossings (at both temporary and permanent crossings), and at dredging or resource extraction (gravel) sites.

PRACTICE DESCRIPTION

Isolation of the work area and collecting or trapping, the sediment for on-site incorporation into streambank stabilization or disposal outside the streambank. This can be done with sediment mats (trademark) or coffer dams on stream diversions or turbidity curtains (see **Construction Management Practices Catalogue** for a description of the turbidity curtain, sediment mat, temporary sediment trap and temporary sediment basin m and water course crossing). Boring under the stream is another alternative.

PRACTICE EFFECTIVENESS

If practices are constructed and operated correctly removal efficiencies range between 80% and 90%. Timing of construction activities, proper diversion of flow and weather forecast awareness can be critical to the effectiveness of these practices. Boring under the stream keeps most sediment out of the stream.

IMPACT ON SURFACE WATER

Beneficial. Hydrologic and habitat modifications are both minimized. Boring has minimal impact on surface water.

IMPACT ON GROUNDWATER

None.

ADVANTAGES

*Reduces nutrients and toxics entering streams attached to sediment particles. *Reduces need for dredging. *Protects instream habitat from being smothered or scoured away. *Boring under the streambed minimizes stream disturbances.

DISADVANTAGES

Turbidity curtains are ineffective in a heavy current. Boring or directional drilling may require a wider staging area than that of a typical pipeline construction right-of-way.

PRACTICE LIFESPAN

These are temporary practices used for the duration of the instream construction project.

COST

See Construction Catalogue for turbidity curtains, temporary sediment trap, temporary sediment basin, temporary water crossing and sediment mat costs. Coffer dam, stream diversion, and boring costs increase with stream width. Cost of boring also increases with amount of bedrock to penetrate.

OPERATION AND MAINTENANCE

Varies according to practices selected. Repair damage to devices; monitor for short-circuiting or leaks; remove accumulated sediment.

MISCELLANEOUS COMMENTS

For permit requirements, see ***Streambank and Shoreline Protection (General*** summary sheet.

REFERENCES

Empire State Chapter. Soil and Water Conservation Society. New York Guidelines for Erosion and Sediment Controls. Syracuse, NY. October 1991.

Fifield, Jerald S., Ph.D. Hydrodynamics, Inc. "What is Required for Effective Sediment Control?" Land and Water. March/April 1994. Pgs. 38-40.

NYS Department of Environmental Conservation. Morton, W. Stream Corridor Management: A Basic Reference Manual. Albany, NY. January 1986.

NYS Department of Transportation. Highway Design Manual. December 1986.

NYS Department of Transportation. Standard Specifications. January 1990. **(Management Practice Design Standard and Specification)**

Peterson, Allen. Section Environmental Specialist. New York State Electric and Gas Corporation. "Controlling Sediment in Streams and Waterways". Land and Water. March/April 1994. Pgs. 35-38.

STREAMBANK AND SHORELINE PROTECTION:
Geotextiles

DEFINITION

Synthetic and natural materials usually in the shape of nets, mats or blankets used to assist the establishment of vegetation or placement of riprap.

WATER QUALITY PURPOSE

To minimize erosion degrading surface waters.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment directly. Indirectly enhances the temperature-modifying and nutrient-absorbing effect of vegetation by holding soil and water.

WHERE USED

Various grades of geotextiles are used in increasingly erosive environments:

- Where vegetation needs protection from wind or water erosion.
- Where mulches need anchoring (slopes).
- Where a higher strength reinforcement than mulch is needed to hold sod or plantings on a site using bioengineering.
- In place of or under riprap (durable, angular and well-graded stone).

PRACTICE DESCRIPTION

Recent classification by product performance has been conducted by the Erosion Control Technology Council (ECTC):

- Low-Velocity Degradable RECPs (Rolled Erosion Control Products) - single-net, organic fiber erosion control blankets used on slopes of moderate length grade with moderate runoff.
- High-Velocity Degradable RECPs - double or high-strength-net made of multiple fibers or higher strength fibers used on steeper slopes of greater runoff quantity and velocity but where natural vegetation is expected to succeed as permanent soil stabilization.
- Long-Term Non-Degradable RECPs - geosynthetic mattings of high tensile strength used for critical area applications requiring immediate and continuing high-performance erosion control.

PRACTICE EFFECTIVENESS	More effective than vegetation alone, but no quantitative data available at this time. Product performance standards are in the development stage. Generally, their effectiveness on slopes is better and longer lasting than conventional loose mulching, tackifiers or hydraulic mulching. Effectiveness is determined primarily by matching the correct product to the site conditions and anticipated or historical erosive forces.
IMPACT ON SURFACE WATER	Beneficial. Aids soil structure in resisting erosive force of runoff.
IMPACT ON GROUNDWATER	None.
ADVANTAGES	*Lighter, less costly than structural improvements. *Immediately stronger than vegetative stabilization. *Longer lived than vegetative stabilization.
DISADVANTAGES	More expensive than vegetation alone.
PRACTICE LIFESPAN	• Low-Velocity Degradable RECPs: one to two growing seasons. • High-Velocity Degradable RECPs: One to five years, functionally. • Long-Term Non-Degradable RECPs: No long-term information.
COST	See Buyers Guide in November/December 1994 issue of Land and Water. Varies with material strength and lifespan. Materials include coconut (coir) fiber, polyethylene, polyester, jute (glossy fiber of one of two East Indian plants), geosynthetics and photodegradable geosynthetics.
OPERATION AND MAINTENANCE	Inspect installation annually and after storms or floods.
MISCELLANEOUS COMMENTS	USEPA requirements for products to contain as much recovered material as practical could affect prices and performance standardization.

REFERENCES

"1995 Buyers Guide". Land and Water. Vol. 38. November/December 1994. Land and Water, Inc. Fort Dodge, IA.

Austin, Deron N. and Toney Driver. "Classifying Rolled Erosion Control Products". In Erosion Control, Journal of the International Erosion Control Association, January/February 1995. Pgs. 48-53.

"Government Buying Guidelines Could Hurt Geotextile Industry". In Erosion Control, Journal of the International Erosion Control Association. January/February 1995. Pgs. 13-14.

Theisen, Marc S. "The Expanding Role of Geosynthetics in Erosion and Sediment Control". Land and Water. Vol. 36. November/December 1992. Land and Water, Inc. Ft. Dodge, IA.

Theisen, Marc S. "The Expanding Role of Geosynthetics in Erosion and Sediment Control". Land and Water. Vol. 37. January/February 1993. Land and Water, Inc. Ft. Dodge, IA.

STREAMBANK AND SHORELINE PROTECTION:
Selective Clearing and Snagging

DEFINITION

Selective removal of trees, log jams, sediments, and other obstructions from the stream channel in order to re-establish the original hydraulic capacity and gradient of the channel.

WATER QUALITY PURPOSE

To restore flow to within the stream channel, decrease erosion of the streambank caused by deflected streamflow, and improve instream habitat.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment, oxygen demand, and thermal changes.

WHERE USED

Upstream from dams, bridges, sharp bends and other constrictions of the channel. Only obstructions causing flooding, significant ponding, or sediment deposition should be removed. Debris dams are desirable in headwaters and midorder streams to sustain the macroinvertebrate population and reduce nutrients delivered to lakes and reservoirs.

PRACTICE DESCRIPTION

Hand operated equipment should be considered first for snag removal. Water-based equipment should be the second choice (e.g. a crane or winch mounted on a small shallow draft barge or other vessel). If use of water-based equipment is not practical the smallest feasible rubber-tired or tread-laying equipment (whichever would minimize ground disturbance) should be specified. Operation of heavy equipment with cables from above the bank or outside the floodplain may be possible in non-wooded areas.

Besides significant blockages of logs, only unrooted trees or logs should be removed from the stream. The only rooted trees that should be removed are those leaning over the stream at greater than a 30 degree angle from vertical. Only large sediment deposits causing ponding or dispersed out-of-channel flow should be removed, unless, in the opinion of an appropriate expert, a particular sediment plug is unlikely to be removed by natural stream forces restored by snag removal.

PRACTICE EFFECTIVENESS

Effective if done selectively. If overdone clearing and snagging can result in destruction of fish cover and ultimately fish propagation and fish survival.

IMPACT ON SURFACE WATER

Beneficial. Increase dissolved oxygen levels and decreased summer temperatures. Moderate (negative) impact downstream if overdone.

IMPACT ON GROUNDWATER

None to minimal. Local groundwater table will drop slightly.

ADVANTAGES

*Restoration of the former hydraulic capacity and gradient of the stream. *Improvement of the coldwater fishery.

DISADVANTAGES

*Can be destructive if not conducted judiciously and with the most appropriate equipment.

PRACTICE LIFESPAN

Until the next out-of-bank flood, or approximately two years.

COST

Depends on the equipment and manpower required, the steepness of the bank and soil type, and the cost of disposal or marketability of extracted logs or sediment. This practice may be eligible for state or federal cost-sharing. Contact the County Soil and Water Conservation District manager for current programs.

OPERATION AND MAINTENANCE

Suspected or historic sites for log jams should be checked annually and after every storm. Deficiencies should be noted and corrected before they become major problems.

MISCELLANEOUS COMMENTS

For permit requirements, see ***Streambank and Shoreline Protection (General*** summary sheet.

REFERENCES

Northern Vermont Resource Conservation and Development Area. Vermont Agency of Environmental Conservation. Extension Service, University of Vermont, Soil Conservation Service. Landowners Guide to Streambank Management. July 1979. Pg. 15.

Nunnally, N. and D. Seniw. "ENDOW Streambank Protection and Flood Control Chennels" (software). US Army Corps of Engineers Waterway Experiment Station. 1988.

NYS Department of Environmental Conservation. Morton, W., Stream Corridor Management: A Basic Reference Manual. Albany, NY. January 1986. Pgs. 71-73.

U.S. Army Corps of Engineers. Streambank Protection Guidelines. Washington, DC. October 1983. Pgs. 32-34.

USDA. Soil Conservation Service. National Handbook of Conservation Practices. "Clearing and Snagging", Syracuse, NY. February 1982. **Management Design Standard and Specification)**

Whalen, Norman A., Project Officer. Nonpoint Source Control Guidance - Hydrologic Modifications. U.S. Environmental Protection Agency, Water Planning Division, Nonpoint Sources Branch, Washington, D.C. February 1977. Page III-4.

STREAMBANK AND SHORELINE PROTECTION:
Stream Grade Stabilization Structures

DEFINITION

Selective use of instream flow control structures to control scouring and sedimentation in the stream channel due to both natural and human causes.

WATER QUALITY PURPOSE

To control where streambed erosion and sediment deposition occur; to control erosion of the toe of the streambank caused by stream channel disturbances; and to improve in-stream habitat.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment, water level/flow alteration.

WHERE USED

*Where past channelizing or damming has significantly altered the stream channel. *Where alternating series of pools and riffles have been excavated, eroded or flooded (A one-to-one ratio of pools to riffles is optimum for sportfish) (see *Improving Instream and Riparian Habitat* summary sheet). *Where other damaging aggradation (deposition) or degradation (erosion) of the streambed cannot be adequately corrected with clearing and snagging, vegetative or biotechnical measures, or upstream water control practices. *To correct localized streambed scouring; check dams, armoring with erosion resistant material, or other grade control structures may be used. *To correct localized streambed depositional areas; current deflectors, habitat-improving dams and cribbing can be used. (**Note:** Structure selection will differ for high and low gradient streams.)

PRACTICE DESCRIPTION

Check dams are vertical structures placed bank to bank across a scouring channel bed. Armoring is lining the bed and lower banks with erosion resistant material such as stone or grass that is tolerant to inundation. Current deflectors are low structures designed to deflect high flow erosive currents away from the streambank and change the streambed form. Habitat-improving dams create small pools by scouring the streambed. A crib is a multi-layered rectangular log structure filled with rock and anchored by logs into the streambank. Hand-operated equipment should be used as much as possible to avoid damaging the streambed and banks. Water (vessel)-based equipment should be the second choice. If use of water-based equipment is not practical the smallest feasible rubber-tired or tread-laying equipment (whichever would minimize streambed disturbance) should be specified. The use of heavy equipment directly in streams or waterbodies and the installation of practice components during periods of high water should be avoided whenever possible. (See *Modifying, Operating and Maintaining Flood Control Structures* summary sheet.)

PRACTICE EFFECTIVENESS	Effective if done selectively. If overdone or done incorrectly, fish spawning beds will be washed away, streambank failure may occur and ultimately fish survival will be impaired.
IMPACT ON SURFACE WATER	Beneficial. Increased dissolved oxygen levels, decreased summer temperatures and decreased instream sediment.
IMPACT ON GROUNDWATER	None.
ADVANTAGES	*Restoration of the former hydraulic capacity and gradient of the stream. *Improvement of the coldwater fishery.
DISADVANTAGES	*Flow-constricting structures are susceptible to obstruction and subsequent flooding by natural snagging or jamming by logs, or by public seeking to "further improve" the stream or just to satisfy curiosity. *Flow-resisting structures may prevent local erosion, but can cause downstream areas to become sediment starved. *Where rip-rap (rock) is used to line a streambed some biodiversity may be lost or altered.
PRACTICE LIFESPAN	Returning the stream channel to a more stable condition with accompanying streambank stabilization should reduce the rate of erosion or deposition in the stream. However, stream bed will always be changing due to natural stream forces.
COST	Depends on the equipment and manpower required, the cost of disposal, if any. Lining channels can be very expensive. This practice may be eligible for state or federal cost-sharing. Contact the county Soil and Water Conservation District manager for current programs.
OPERATION AND MAINTENANCE	Suspected or historic sites for log jams should be checked annually and after every storm. Deficiencies should be noted and corrected before they become major problems.
MISCELLANEOUS COMMENTS	For permit requirements, see the ***Streambank and Shoreline Protection (General)*** summary sheet.

REFERENCES

Empire State Chapter, Soil and Water Conservation Society, New York Guidelines for Urban Erosion and Sediment Control. Syracuse, NY. October 1991.

Northern Vermont Resource Conservation and Development Area. Vermont Agency of Environmental Conservation-Extension Service, University of Vermont, Soil Conservation Service. Landowners Guide to Streambank Management. July 1979. Pgs. 10-11.

Helfrich, L.A., D.L. Weigmann, R.J. Neves, P.T. Bromley. Landowner's Guide to Managing Streams in the Eastern United States. Publication 420-131. Virginia Polytechnic Institute and State University. Blackburg, VA. (Reprinted: September 1986.) Pg. 18.

Schumm, S.A. The Fluvial System. John Wiley and Sons, Inc. New York. 1977. 338 pgs.

U.S. Army Corps of Engineers. Streambank Protection Guidelines For Landowners and Local Governments. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. October 1983. Pgs. 5 and 34.

USDA. Soil Conservation Service. National Handbook of Conservation Practices. "Stream Channel Stabilization" and "Grade Stabilization Structure". Syracuse, NY. February 1982. **(Management Design Standard and Specification)**

STREAMBANK AND SHORELINE PROTECTION:
Structural Slope Protection

DEFINITION

The stabilization of steep or erosive slopes with rip-rap, retaining walls, or other non-vegetative materials either:
- **a)** on the streambank or
- **b)** upslope of the stream channel.

WATER QUALITY PURPOSE

To reduce the movement of sediment into waterbodies.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment.

WHERE USED

On hillsides or cliffs on or upslope of streambanks where seepage problems, toe instability, or other site limitations preclude the use of vegetation or mulches alone.

PRACTICE DESCRIPTION

a) Structural slope protection includes loose or grouted rock rip-rap, cribbing or retaining walls, and concrete block paving. Brush, trees, stumps, and other objectionable materials are removed and the slope is properly graded before installing this practice. Drainage, filter and bedding materials are installed prior to the structure. *Rip-rap (durable, angular, and well-graded stone) size is specified according to site conditions. Void spaces are minimized. *Retaining walls may be cast-in-place concrete, precast concrete units, metal bin-type or gabions (stone placed in wire mesh cages). *Slope paving consists of solid concrete blocks (about 18"L x 6"T x 8"W) and may be grouted. Complexities such as foundation bearing cap-acity, sliding, overturning, drainage and loading systems re-quire careful design of retaining walls and slope paving,

b) where streams cut into the toe of an excessively steep hillside and slope regrading is impractical, it may be possible to relocate the stream. Excavated material from the opposite bank is used to form a bench along the toe of the slope, effectively moving the stream away from the eroding cliff or hillside. Surface drainage from the upslope area should be diverted to a stable outlet and prevented from flowing down over the steep slope causing further erosion.

PRACTICE EFFECTIVENESS

a) Retaining walls and rip-rap provide good control of soil erosion problems on slopes. Proper design and installation is essential. Slope paving is not as commonly used. Results expected are similar to those for other forms of structural slope protection,

b) effective where site conditions allow for stream relocation, and upslope land is accessible.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUNDWATER

None.

ADVANTAGES

a) *Loose rip-rap is usually easy to install. *Little maintenance is normally required,

a & b) *Useful practice where land rights limit flattening of slopes.

DISADVANTAGES

a) *Non-porous materials will increase stormwater runoff. *Design of retaining walls is usually complex. *Rip-rap is normally not suited to slopes steeper than 1½:1,

b) *May involve disputes over transfer or sale of property rights.

PRACTICE LIFESPAN

Permanent. Ten (10) years or longer.

COST

Moderate to high.

OPERATION AND MAINTENANCE

Inspect annually for soil subsidence, rock displacement, wall or block movement, and clogged drains. Repair promptly. Control woody growth where structural integrity is threatened. Sites often involve public safety hazards such as road closures and stream blockages.

MISCELLANEOUS COMMENTS

Soil stability and internal drainage are extremely important considerations for the proper design and installation of this group of practices. Adjacent disturbed areas should be seeded and mulched immediately. For permit requirements, see ***Streambank and Shoreline Protection (General)*** summary sheet.

REFERENCES

Empire State Chapter. Soil and Water Conservation Society. New York Guidelines for Urban Erosion and Sediment Control. Syracuse, NY. October 1991. **(Management Practice Design Standard and Specification)**

NYS Department of Transportation. Standard Specifications. January 1990. **(Management Practice Design Standard and Specification)**

USDA. Soil Conservation Service. Engineering Field Handbook, Chapter 18 "Soil Bioengineering for Upland Slope Protection and Erosion Reduction". 1992. **(Management Practice Design Standard and Specification)**

WATER QUALITY AND HABITAT PROTECTION: Constructed Wetlands

DEFINITION

A constructed, shallow water area, usually a freshwater marsh, dominated by cattail, bulrush, rushes or reeds, designed to simulate the water quality improvement function of natural wetlands. Constructed wetlands are the last component in wastewater and stormwater treatment systems.

WATER QUALITY PURPOSE

For the physical, chemical and biological treatment of stormwater runoff or final wastewater polishing.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Nutrients, trace organic compounds, pathogens, metals, and sediment.

WHERE USED

Constructed downstream from stormwater management structures (e.g., infiltration, retention and detention practices); below barnyards, feedlots, concentrated livestock areas; below food processing and milkhouse waste filter strips and agricultural fields; below specially designed on-site wastewater treatment systems. Constructed tidal wetlands should only be placed downstream of a freshwater wetland.

PRACTICE DESCRIPTION

Constructed wetlands can be designed in two ways: "free water surface systems" and "subsurface flow systems". Free water surface systems consist of basins or channels with a natural or constructed subsurface barrier to prevent seepage. Soil or another suitable medium supports emergent vegetation. Water depth is shallow, and flows over the soil surface of the wetland.

Subsurface flow systems consist of trenches or beds underlain with a natural or constructed impermeable subsurface barrier. Soil or gravel is used in the trench or bed to support emergent vegetation. The wetland is constructed with a slight inclination between inlet and outlet. Stormwater runoff to be treated is introduced into the wetland via drainage pipe and a stone-filled trench. Treated effluent leaves the wetland via drainage pipe in a stone-filled trench, hence the name "subsurface flow system".

PRACTICE EFFECTIVENESS

The performance of any constructed wetland system is dependent upon precipitation, infiltration, evapotranspiration, hydraulic loading rate, water depth and pH. All effect the removal of organics, nutrients, and trace elements not only by altering detention time, but also by either concentrating or diluting the stormwater.

Nitrogen removal, due to nitrification/denitrification, ranges from 25-85%. Phosphorus removal in wetlands is not very effective because of the limited contact opportunities between the wastewater and the soil. When the hydraulic residence time of the artificial wetland ranges from 5 to 7 days, fecal coliform removal efficiency rates range from 65 to 99%. Similar removal efficiency rates were achieved for viruses. Removal efficiency rates of more than 95% have been reported for the heavy metals copper, zinc and cadmium.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUNDWATER

Beneficial. In areas of highly permeable soils, constructed wetlands will require a watertight membrane lining.

ADVANTAGES

*Aesthetically pleasing. *Benefits wildlife. *Uses low-cost, low-maintenance technology. *Efficient for nitrogen, metals, fecal coliform and virus removal.

DISADVANTAGES

*Requires large land area. *May become a breeding ground for disease producing organisms and insects, and may generate odors if not properly managed. *A newly introduced aquatic plant species may become a nuisance, involving non-wetland areas. *Low pollutant removal rate during non-growing season. *Not effective for phosphorus removal.

PRACTICE LIFESPAN

Approximately 20 to 25 years.

COST

Varies depending upon size needed. Typically, design and construction costs are slightly higher than for wet ponds due to costs associated with environmental analysis, complex grading and hydrophytic vegetation plant materials. Watertight membrane liners are very expensive.

OPERATION AND MAINTENANCE

Operations and maintenance typically consists of inspecting dike integrity, and vegetation, and mowing dikes surrounding the constructed area. For free water surface systems, dry grasses are burned off annually to help maintain the hydraulic profile of the wetland, and avoid build-up of grassy hillocks which encourage channelization. Harvesting of wetland vegetation is not necessary for subsurface flow systems. Sediment must be periodically removed.

MISCELLANEOUS COMMENTS

Prior to design of a constructed wetland, contact the Regional Office of the NYS DEC for information on state wetland regulations. (See *Streambank and Shoreline Protection* summary sheet.)

Special Note on use of Existing Wetlands: It is not acceptable to discharge untreated stormwater directly into naturally existing wetlands. Direct, untreated discharges may overload the natural system, and make it impractical to manage (e.g., by periodic sediment removal) resulting in contamination of the wetland and accelerated succession. Direct discharges also may alter the hydrology and hydroperiod of the wetland, which may significantly alter the vegetative community therein.

However, incorporating an existing wetland in its natural state into a well-designed stormwater management plan may be an acceptable method of stormwater management when adverse impacts to the wetland can be avoided. Natural wetlands should be used only for final polishing after pretreatment by preliminary practices, such as infiltration, retention or extended detention. In these situations, ultimate discharge to the natural wetland may maintain base flow into the system, thereby helping to maintain the health of the wetland.

REFERENCES

USDA. Soil Conservation Service. National Handbook of Conservation Practices. "Wetland Development or Restoration". Washington, DC. December, 1990. **(Management Practice Design Standard and Specifications)**

USDA. Soil Conservation Service. "Nutrient/Sediment Control System". Orono, Maine. March, 1991. **(Management Practice Design Standard and Specifications)**

USEPA. Created and Natural Wetlands for Controlling Nonpoint Source Pollution. Edited by Richard K. Olson, Office of Wetlands, Oceans and Watersheds. C.K. Smoley, Publisher. 1993.

USEPA. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. Office of Water. January 1993. Pgs. 7-47 to 7-66.

USEPA. Natural Wetlands and Urban Stormwater: Potential Impacts and Management. USEPA Office of Wetlands, Oceans and Watersheds. Wetlands Division. Washington, DC. February 1993.

USEPA. Design Manual: Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment. USEPA Office of Research and Development and Center for Environmental Research Information. Cincinnati, OH. September 1968. **(Management Practice Design Standard and Specifications)**

WATER QUALITY AND HABITAT PROTECTION: Improving Instream and Riparian Habitat

DEFINITION

Instream and on-bank structures built, or vegetation grown, to improve or create fish habitat in the stream and enhance biodiversity, generally, in the riparian buffer.

WATER QUALITY PURPOSE

To benefit classified uses of fishing, fish survival and fish propagation and to improve aesthetics.

SOURCE CATEGORY

Hydrological and Habitat Modification.

POLLUTANTS CONTROLLED

Oxygen demand, water level/flow, sediment and thermal changes.

WHERE USED

*Instream areas where pool and riffle ratios need improvement to vary water depth and flow to provide required habitat. *Near streams where shading is needed. *Riparian areas that have highly erodible soils needing stabilization including steep banks, dams, dikes, levees, mine spoil and other spoil areas, cuts or fills and denuded or gullied areas.

PRACTICE DESCRIPTION

<u>Instream</u>: simple flow altering structures such as boulder placement, small rock or log dams, artificial riffles, log or rock bank covers, and instream current deflectors. Structures should be placed evenly at intervals of 5 to 7 times the stream width and pool to riffle ratio should be about one-to-one. The goal is to provide shade, pools, shelter and food supply similar to the natural channel prior to modification or degradation. Other improvements can be made to the stream channel itself. (see ***Stream Grade Stabilization Structures***).

<u>Riparian areas</u>: see Management Practice summary sheets for ***Riparian Forest Buffer, Streambank and Shoreline Protection*** and ***Stream Corridor Protection Program***.

Preservation of oxbows and excavation of a channel in the floodway can provide flood control at high flow times and increased riparian buffer areas.

PRACTICE EFFECTIVENESS

Effectiveness depends on using a comprehensive stream system approach. The macrohabitat must be suitable for target species before instream alterations can enhance the microhabitats. For example, the stream's flow regime must be in equilibrium. Erratic changes in flow can alter pool-riffle ratios, and thus the habitat suitability, of the stream regardless of structures installed.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUNDWATER

None.

ADVANTAGES

*Increased aeration. *Increased shading and, as a result, lower summer temperatures and less algae. *Increased diversity and greater population of game fish food (invertebrates) and game fish. *Attenuates flooding. *Reduced streambank erosion.

DISADVANTAGES

*May require conversion of land uses to riparian buffer area or increased floodplain area that may be perceived by some or many as encroachment on developable lands or private land ownership rights. *Flow constricting improvements are susceptible to log jams or snags, or blockage by public seeking to "further improve" the stream.

PRACTICE LIFESPAN

This will depend on the amount of protection the newly restored habitat is given, in proportion to how much upkeep and repair of structures or vegetation is needed. Use of native species may increase the stability of the improved habitat. However, streams and banks are always subject to succession and human abuse.

COST

Most work is hand labor so cost depends on site accessibility, availability of volunteer labor, and methods chosen.

OPERATION AND MAINTENANCE

Control access to improvement areas. Inspect improvement areas periodically. Depending on the improvement, maintenance could include mowing, controlled grazing, applying approved chemicals or fertilizers, repair of components, reseeding, replanting, irrigation or the addition of soil amendments.

MISCELLANEOUS COMMENTS

Deflectors, habitat-improving dams, small logs and cribbing should be installed at low water level and constructed so that all components will be continuously submerged. This is to preserve wooden components and allow high water and ice floes to pass freely.

REFERENCES

Karr, James R. and Isaac J. Schlosser. "Water Resources and the Land-Water Interface". Science. Vol. 201, July 1978. Pgs. 229-234.

NYS Department of Environmental Conservation. Morton, W. Stream Corridor Management: A Basic Reference Manual. Albany, NY. January 1986.

NYS Department of Environmental Conservation. Hulbert, Phillip J. "The Scope and Direction of Stream Improvement in New York". Published in Proceedings of the Trout Stream Habitat Improvement Workshop. Asheville, NC. November 3-6, 1980.

USDA - Forest Service Southern Region. Stream Habitat Improvement Handbook. Technical Publication R8-TP16. June 1992.

USDA - Soil Conservation Service. National Handbook of Conservation Practices. "Channel Vegetation", October 1977; "Critical Area Planting", "Fish Stream Improvement", October 1977 and supplements-1983. **(Management Practice Design Standard and Specification)**

Miller, J.G. and R. Tibbot. Revised by D. Houser and K. Lutz Fish Habitat Improvement for Trout Streams. Pennsylvania Fish and Boat Commission. Harrisburg, PA. 1992.

MANAGEMENT PRACTICE SUMMARY SHEET

WATER QUALITY AND HABITAT PROTECTION:
Restoring Freshwater Wetlands

DEFINITION

Reestablishing the functions and character of a wetland that have been degraded or lost by actions such as filling, excavating, draining, altering hydrology, loss of adequate buffer, or introduction of contaminants to return a degraded or former freshwater wetland (land that was once a freshwater wetland) to a close approximation of a predisturbance condition.

WATER QUALITY PURPOSE

To buffer or reduce nonpoint source impacts to downstream waterbodies brought about by the loss or degradation of freshwater wetlands.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment, trace organic compounds, pathogens and heavy metals.

WHERE USED

Where past activities have significantly altered freshwater wetlands to the point where they are severely degraded or no longer function as wetlands.

PRACTICE DESCRIPTION

Excavation of fill exposes original substrate and alters topography to provide flushing and suitable depths for reestablishment of native vegetation. Water level manipulation restores hydrology to favor native species and affects nutrient, dissolved gas and other chemical concentrations. Revegetation with native plants provides desirable habitat for native fauna. Reestablishing buffer areas increases filtering capacity and decreases nutrient and pollutant concentrations. Nuisance species control aids native species restoration.

PRACTICE EFFECTIVENESS

Practice has been proven to be highly effective at restoring wetlands. An increase in nonpoint source removals occurs but is difficult to measure.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUNDWATER

Beneficial.

ADVANTAGES

*Long-term water quality benefits through increased biological and chemical oxidation capacity and reduced sedimentation. By attenuating flows from storm events, wetlands provide flood control and protect receiving waters from hydraulic impacts such as channel scour, streambank erosion, and fluctuations in temperature and chemical characteristics *Provides aesthetically pleasing open space and wildlife habitat for resident and migratory species. *Commercial fishery improvement. *May serve as groundwater recharge sites, but more frequently serve as headwater (or stream origin) sites.

DISADVANTAGES

Restoration often requires trade-offs: *Reversion of drained land back to wetland *May result in reduced property taxes, reducing tax base *May require a large area to be successful at restoring a full range of wetland benefits. *Wetlands may be perceived to be a breeding ground for nuisance species (e.g., insects).

PRACTICE LIFESPAN

Restoration to a more natural self-sustaining state should result in an indefinite lifespan subject to natural succession and degradation processes, and human activities.

COST

Varies with scale of restoration project. Can range from hundreds to tens of thousands of dollars per acre.

OPERATION AND MAINTENANCE

Frequent site inspections at the start to determine whether hydrology and plantings have been established and later to measure restoration success. Some restoration efforts require periodic maintenance; planners should pursue maintenance-free restoration techniques first.

MISCELLANEOUS COMMENTS

Successful wetland restoration decreases the existing pollutant loadings to receiving waters. It is not intended as a substitute for such practices as infiltration or extended detention which may be necessary to abate pollution from new development. (See special note on use of existing wetlands in the *Constructed Wetlands summary sheet.*)

The level of restoration planning and design should be commensurate with the magnitude of site alteration. Site history, existing conditions, and federal, state and local wetland and water quality goals are some of the factors that must be clearly articulated and considered to determine the environmental soundness of restoration and the predictability of its long-term success.

This practice may be eligible for cost-sharing under U.S. Fish and Wildlife Service's Private Lands Initiative, and U.S. Department of Agriculture's Wetlands Reserve Program.

Individuals wishing to restore wetlands should contact their Regional Office of the Dept. of Environmental Conservation to determine whether an Article 15-Protection of Waters Permit; Article 24-Freshwater Wetlands Permit; Article 25-Tidal Wetlands Permit; Article 36-Floodplain Permit are required; as well as possible requirements for work proposed along a stream or river protected under the Wild, Scenic and Recreational Rivers Act. A federal Section 404, Section 401, or Section 10 federal permit may also be required.

REFERENCES

Hammer, D.A. Creating Freshwater Wetlands. Lewis Publishers. 1992.

Kusler, J.A. and G. Brooks. "Wetland Hydrology". Proceedings of the National Wetland Symposium. Association of State Wetland Managers. Berne, NY. 1987.

Kusler, J.A. and M.E. Kentula. Wetland Creation and Restoration: The Status of the Science. Island Press. 1990.

Luttenberg, D., D. Lev and M. Foller. Native Species Planting Guide for New York City and Vicinity. Natural Resources Group. City of New York Parks and Recreation. 1993.

Marble, A.D. A Guide to Wetland Functional Design.. Lewis Publishers. 1992.

USDA. Soil Conservation Service. National Handbook of Conservation Practices. "Wetland Development or Restoration". Washington, DC. December 1990. **(Management Practice Design Standard and Specification)**

USEPA. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. Office of Water. January 1993. Pgs. 7-33 to 7-46.

WATER QUALITY AND HABITAT PROTECTION:
Restoring Tidal Wetlands

DEFINITION

Reestablishing the functions and character of a tidal wetland that have been degraded or lost to a close approximation of a predisturbance condition.

WATER QUALITY PURPOSE

To reduce the current pollutant loading to coastal waters brought about by the historic loss or degradation of tidal wetlands.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediment, trace organic compounds, pathogens and heavy metals.

WHERE USED

Where human activities such as filling, substrate removal, draining, altering hydrology, loss of adequate buffer, or introduction of contaminants have degraded tidal wetlands.

PRACTICE DESCRIPTION

Excavation of fill exposes original subtrate and alters topography to allow flushing and suitable depths for reestablishment of native vegetation. Water level manipulation restores hydrology to favor native species and affects nutrient, dissolved gas and other chemical concentrations. Revegetation with native plants provides desirable habitat for native fauna. Reestablishing buffer areas increases filtering capacity and decreases nutrient and pollutant concentrations. Nuisance species control aids restoration of native species.

PRACTICE EFFECTIVENESS

Practice has been effective for some categories of tidal wetlands.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUNDWATER

None or Unknown.

ADVANTAGES

A tidal wetland restored to a self-sustaining system provides: *An increased land/water interface capable of reducing pollutants in coastal waters and runoff through biological and chemical oxidation; *Additional erosion control through wave attenuation and flood storage; *Reduction of hydraulic impacts along tributaries (e.g., channel scour, streambank erosion); fluctuations in temperature and chemical characteristics; *Aesthetically pleasing open space; *Wildlife habitat (i.e., breeding, nesting and feeding) for resident and migratory species; and *Recreational and commercial fishery improvement by providing higher quality nursery and feeding habitat for many valuable species.

DISADVANTAGES

Restoration often results in trade-offs: *Filling may result in temporary sediment increase. *Excavation may uncap or expose contaminants. *Loss of drained former wetlands. *May require a large area to be successful at restoring a full range of wetland benefits. *Wetlands may be perceived to be a breeding ground for nuisance species (e.g., insects).

PRACTICE LIFESPAN

Restoration to a more natural self-sustaining state should result in an indefinite lifespan subject to natural succession and human activities.

COST

Varies with scale of restoration project. Costs range from about one thousand to tens of thousands of dollars per acre. This practice may be eligible for cost-sharing under Section 319 of the Clean Water Act; U.S. Fish and Wildlife Service's, Partners in Wildlife; or North American Waterfowl Management Plan.

OPERATION AND MAINTENANCE

Some restoration efforts require periodic maintenance; planners should pursue maintenance-free restoration techniques first. Frequent inspections should be performed at the start of both to determine whether hydrology and plantings have been established.

MISCELLANEOUS COMMENTS

Wetland restoration decreases the pollutant loadings to receiving waters which have resulted from previous degradation of wetlands. It is not intended as a substitute for such practices as infiltration or extended detention which may be needed to abate pollution from new development. (See special note on use of existing wetlands in the ***Constructed Wetlands*** summary sheet.)

Individuals wishing to restore tidal wetlands should contact their Regional Office of the Dept. of Environmental Conservation for an Tidal Wetlands Permit. (For other permits that may be required (see ***MISCELLANEOUS COMMENTS*** in the ***Restoring Fresh-water Wetlands*** summary sheet.)

REFERENCES

Bongiorno, S. Krautman, Jr. and T. Steinke. 1984. "A Study of Restoration in Pine Creek Salt Marsh, Fairfield, CT". Proceedings of the Eleventh Annual Conference on Wetland Restoration and Creation. Hillsborough Community College. Tampa, FL.

Daiber, F. Conservation of Tidal Marshes. Van Norstrand Reinhold Co. 1986.

Tenth Annual Conference on Wetland Restoration and Creation. Hillsborough Community College. Tampa, FL.

Zedler, J., 1984. Salt Marsh Restoration, a Guidebook for Southern California. CA. Sea Grant Program. Report No. T-CSGC-009. University of California. LaJolla, CA 92093.

WATER QUALITY AND HABITAT PROTECTION: Riparian Forest Buffer

DEFINITION

A corridor of trees, shrubs and grasses of varying width located adjacent to and upgradient from waterbodies.

WATER QUALITY PURPOSE

To intercept and filter stormwater runoff, subsurface flow and groundwater flow from upland sources.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Nutrients, sediment, organic matter, some pesticides, and thermal modification.

WHERE USED

At the margins of lakes, ponds, wetlands and streams; on karst (limestone) formations, at the margin of sinkholes, and other small groundwater recharge areas; between urban, suburban and industrial development areas and urban waterbodies.

PRACTICE DESCRIPTION

Riparian forest buffers consist of three distinct zones and are designed to convert surface runoff to sheet flow and filter subsurface flow. Stream-side forest buffers are designed to facilitate infiltration and diffuse concentrated flow.

Zone 1 begins at the top of the streambank and occupies a strip of land with a fixed width of fifteen to 25 feet measured horizontally on a line perpendicular to the streambank. Predominant vegetation is composed of a variety of native riparian tree and shrub species and such plantings as necessary for streambank stabilization during the establishment period.

Zone 2 begins at the edge of Zone 1 and occupies an additional strip of land with a minimum width of 50-60 feet. Predominant vegetation is the same as Zone 1. Nitrogen fixing species should be discouraged where nitrogen removal or buffering is desired.

Zone 3 begins at the outer edge of Zone 2 and has a minimum width of 20-25 feet. Vegetation is composed of dense grasses and forbs for soil stabilization, sediment control and nutrient uptake. Mowing and removal of clippings is necessary to recycle nutrients harvested by vegetation, promote vigorous sod and control weed growth.

PRACTICE EFFECTIVENESS

The riparian forest buffer will be most effective when used as a component of a sound land management system including nutrient management, runoff, and sediment and erosion control practices (for example, the use of filter strips in or upgradient of Zone 3). With upslope stormwater control, filter strips are very effective for sediment and sediment-bound pollutant removal with trapping efficiencies exceeding 50%. In riparian zones they have trapped 85-90% of the sediment and up to 50% of the phosphorus leaving cultivated fields. Filter strips do not remove soluble phosphorus or nitrates effectively.

IMPACT ON SURFACE WATER

Beneficial.

IMPACT ON GROUNDWATER

Beneficial to slight. Practice may increase transport of pollutants to groundwater by increased infiltration.

ADVANTAGES

*Low cost, cost-effective approach to surface water control of runoff. *Protects/creates wildlife habitat. *Provides natural screening and sound protection.

DISADVANTAGES

*Require a large land area. *May not be feasible in highly developed areas where runoff velocities become erosive.

PRACTICE LIFESPAN

Thirty to 50 years, or more.

COST

Relatively low for seeding grasses, and tree planting.

OPERATION AND MAINTENANCE

Inspect annually and immediately following severe storms for evidence of sediment deposit, erosion or concentrated flow channels. Avoid use of fertilizers, pesticides, other chemicals, vehicular traffic or disturbance of vegetation and litter inconsistent with erosion control and buffering objectives. Except for periodic cutting of mature trees, Zones 1 and 2 should remain undisturbed. Zone 3 should be mowed periodically and clippings removed to promote dense vegetative growth and removal of nutrients. Periodic replacement of dead plant specimens.

MISCELLANEOUS COMMENTS

None.

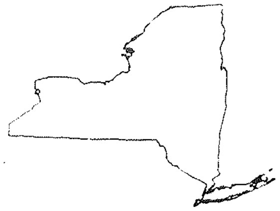
REFERENCES

Center for Watershed Protection. Schueler, Thomas R. Urban Watershed Management: Design of Urban BMPs. Silver Springs, MD. 1987.

Metropolitan Washington Council of Governments. Schueler, Thomas R. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Washington, DC. 1987. **(Management Practice Design Standard and Specification)**

NYS Department of Environmental Conservation. Morton, William B. Reducing the Impacts of Stormwater from New Development. Albany, NY April 1992.

USDA. Forest Service and Soil Conservation Service. Riparian Forest Buffers. Washington, DC. January 1991. **(Management Practice Design Standard and Specification).**



MANAGEMENT PRACTICE SUMMARY SHEET

WATER QUALITY AND HABITAT PROTECTION
Stream Corridor Protection Program (Greenbelting)

DEFINITION

A program to protect and restore a stream corridor, carried out in cooperation with a unit of government (federal, state or local), the residents of the watershed and other interested conservation organizations.

WATER QUALITY PURPOSE

Water quality protection and enhancement through the control of nonpoint sources in the stream corridor.

SOURCE CATEGORY

Hydrologic and Habitat Modification.

POLLUTANTS CONTROLLED

Sediments, nutrients, pesticides, pathogens, metals and thermal modifications.

WHERE USED

Can be used in all watersheds.

PRACTICE DESCRIPTION

Stream corridor protection programs consist of the following management options:

- **Policy Development** - to guide activities of land users toward pollution source control through the use of management practices.
- **Information and Education** - for local policy and decision makers and to increase public awareness and involvement in implementing the program.
- **Land Acquisition** - for protecting critical environmental areas (i.e., riparian zones) by purchase, lease, donation or easement.
- **Land Use Controls** - for example, zoning, floodplain regulations, riparian forest buffer setbacks, and single purpose ordinances.
- **Tax Incentives** - offered to landowners for maintaining riparian zones as farm, forest, scenic vista or public access to streams.
- **Governmental Aid Programs** - for technical and financial assistance associated with the installation of conservation practices.
- **Special Improvement Districts** - established around a stream corridor, so that taxes can be levied to finance operation and maintenance expenses connected with improvements in the stream corridor.
- **Watershed Rules and Regulations** - for the protection of public/private drinking water supplies.

PRACTICE EFFECTIVENESS	Stream corridor protection, when implemented as a watershed-wide program, is very effective as a means of long-term pollution prevention. Remedial practices, such as streambank protection with permanent vegetation, are also very effective in restoring and enhancing the stream corridor. Practices involving retention and restoration of riparian vegetation can have dramatic effects on lowering summer stream temperatures by as much as 10° to 20°F, resulting in a reduction of thermal stress on aquatic organisms.
IMPACT ON SURFACE WATER	When components of a stream corridor management program are implemented there are beneficial impacts on surface water.
IMPACT ON GROUNDWATER	When components of a stream corridor management program are implemented there are beneficial impacts for groundwater.
ADVANTAGES	*Benefits to society include water supply protection, recreation, groundwater recharge, wildlife habitat protection, flood storage and retention, navigation, hydropower and protection of cultural resources. *Stream corridors, when properly managed, function as watershed buffer strips.
DISADVANTAGES	*Stream corridor management is highly dependent upon landowner, institutional, and financial support.
PRACTICE LIFESPAN	Most programs are long-term initiatives.
COST	The cost varies depending upon the stream corridor protection program component installed. State or federal cost-sharing may be available (e.g. Stewardship Incentive Program); contact the county SWCD or regional DEC for current program information.
OPERATION AND MAINTENANCE	Perform operation and maintenance on structural and vegetative practices installed as part of the stream corridor protection program.
MISCELLANEOUS COMMENTS	One of the most important state programs to protect and enhance rivers, streams and their corridors, was established in 1972 through the enactment of the NYS Wild, Scenic and Recreational Rivers Program. This is a state program that encourages maximum local initiative in the development, implementation and administration of river conservation studies and plans, providing fundamental regulatory protection for rivers designated in the system. For further information on how your community can participate, contact your NYSDEC Regional Office or the Adirondack Park Agency. Sample local laws/ordinances for protective stream corridors are available from the NYSDEC, 50 Wolf Rd., Bur. of Water Quality Mgmt., Rm. 326, Albany, NY 12233-3508.
REFERENCES	Long Island Regional Planning Board. Koppelman, et al., Evaluation of Land Use Impacts on Environmental Quality in Urban and Semi-rural Streams Tributary to Great South Bay. Hauppauge, NY. March 1990. NYS Department of Environmental Conservation. Morton, William B., Stream Corridor Management: A Basic Reference Manual. Albany, NY. August 1985.

APPENDIX

Some of the management and maintenance activities or structures described in this catalogue require additional structural, vegetative or operational management practices for land uses upslope of the waterbody. This Appendix lists selected practices from other catalogues in this series of Nonpoint Source Pollution Control Management Practice Catalogues.

Selected Management Practices for Agriculture

Constructed Wetlands

Critical Area Protection:
- Permanent Vegetative Cover
- Streambank and Shoreline Protection

Diversions

Fencing

Filter Strips

Grassed Waterway

Irrigation Water Management:
- Scheduling
- Trickle Irrigation

Nutrient/Sediment Control System

Riparian Forest Buffer

Terraces

(Refer to the **Agriculture Management Practices Catalogue** for detailed information about each practice.)

Selected Management Practices for Urban/Stormwater Runoff

Catch Basins

Collection & Treatment of Stormwater

Critical Area Protection:
- Mulching
- Permanent Vegetative Cover
- Streambank & Shoreline Protection

Diversions

Dry Detention Basins

Extended Detention Basin

Filter Strips

Fluidic Flow Regulators

Grassed Swales

Grassed Waterway

Implementation of Land Use Planning

Infiltration Basins & Pits

Integrated Pest Management (IPM)

Irrigation Water Management:
- Scheduling

Retention Pond (Wet Pond)

Riparian Forest Buffer

Stormwater Conveyance System Storage

Stream Corridor Protection Program (Greenbelting)

(Refer to the **Urban/Stormwater Runoff Management Practices Catalogue** for detailed information about each practice.)

August 1995

Selected Management Practices for Construction

Administrative Control Mechanisms

Check Dams

Construction Road Stabilization

Construction Waste Management

Critical Area Protection:
- Mulching
- Temporary Vegetative Cover
- Structural Slope Protection
- Streambank & Shoreline Protection

Diversion

Filter Strip

Grade Stabilization Structure

Grassed Waterway

Hazardous Material Management

Level Spreader

Lined Waerway or Outlet

Paved Flume

Pipe Slope Drain

Planned Land Grading

Sediment Mat

Silt Fence

Stabilized Construction Entrance

Staged Clearing and Grading

Storm Drain Inlet Protection

Straw Bale Dike

Subsurface Drain

Sump Pit

Temporary Dike/Swale

Temporary Sediment Basin

Temporary Sediment Trap

Temporary Storm Drain Diversion

Temporary Watercourse Crossing

Topsoiling

Turbidity Curtain

Waterbar

(Refer to the **Construction Management Practices Catalogue** for detailed information about each practice.)

August 1995