WATERSHEDS

By: EKNATH V. MARATHÉ
MEMBER, ECOLOGICAL AND ENVIRONMENTAL ADVISORY COMMITTEE

WHAT IS A WATERSHED?

A watershed is a land area from which water drains to a stream, river, lake, or ocean. The landscape is made up of many connected watersheds, with large watersheds. What happens in a small watershed can impact a larger watershed downstream.

FEATURES OF A WATERSHED

Watershed have many different features. Some have mountains and hills. Others are nearly flat. Nevertheless, every watershed consists of three main parts: the watershed boundaries, the contributing area or basin, and the surface water body (stream, river, or lake).

The boundaries of a watershed are marked out on a map by drawing a line connecting the highest topographic points of two adjacent areas. These topographic highs can be envisioned as the lip of a funnel. The contributing area or basin -- the major area of a watershed -- would be the sides of a funnel. The collection area or water body would be the spout of the funnel.

Natural watersheds are determined by physical landforms resulting from the interplay of two opposing forces: uplift and degradation. Uplift is the physical force resulting in mountain building. Degradation is the erosion of landforms by water, wind, and gravity. More than any other factor, geology controls the size, length, shape, and slope of watersheds.

WATER, WATER EVERYWHERE

When water falls on a watershed as rain and snow, some flows out very quickly, some is stored in various ways and for various lengths of time, and some evaporates back to the atmosphere or percolates to deep groundwater aquifers (underground areas of porous sand, gravel, or fractured rock).

The water that does not evaporate, percolates to deep aquifers, or become diverted to another watershed by humans ultimately flows to the river, stream, lake, or ocean that drains the watershed. These surface water systems receive their waters from a combination of overland surface flow and groundwater flow.

In many complex geologic structures, surface-water systems may receive groundwater from aquifers that has originated from a different watershed. For the purpose of this minimonograph, discussions will be limited to surface watersheds.

WATER QUANTITY AND QUALITY

The physical characteristics of a watershed -- soil, geology, vegetation, and slope -- control the quantity and quality of water that flows from it. Natural or human-caused changes to any of these characteristics can impart water quantity and quality.

For example, the removing of vegetation by fire or through development will change the storage and infiltration characteristics of a watershed. Replacing natural vegetation with streets, parking lots, and roofs will increase the quantity of water runoff, resulting in a larger quantity of water in a stream or river, often increasing the chance of flooding.

As water moves, it dissolves or carries many different materials. Streams, rivers, or lakes provide a fingerprint of the activities that take place in the watershed. By sampling the quality and quantity of surface water over time, an investigator is abe to determine changes in the physical and chemical characteristics of the watershed such as:

- increased use of pesticides, herbicides, or fertilizers
- poor waste disposal practices
- increased development
- natural hazards (landslides, fires, insect infestation, floods, droughts)
- or improper land use (overgrazing, poor timber management practices, uncontrolled land disturbances resulting from construction)

Because water quality and flow characteristics in a surfacewater body are affected by events occurring throughout the entire watershed, these changes need to be viewed from an areawide perspective.

FLOODS AND FLOODPLAINS

Floods occur when the volume of water in a stream, river, or lake exceeds the capacity of the water body. Any watershed can flood -- you can have a flood in the watershed in your backyard if you leave the sprinkler on too long. Floods usually result from events such as a large amount of precipitation or the failure of a dam.

The volume of water in a natural flood is a function of the size of the watershed, the amount of precipitation within that watershed, and the ability of the watershed to dissipate the water.

The size or magnitude of a flood is described by a term called recurrence interval. By studying flow records over a long period, it is possible to estimate the size of a flood that would, for example, have a 100-year recurrence interval (a 100-year flood). On average, a 100-year flood would occur every 100 years. There is, however, a one percent chance that a 100-year flood could happen during any year. Also, as more information is available concerning the flow regime of a stream or river, and as changes to a watershed occur, the recurrence interval can change.

The large the watershed, the greater the collection area for precipitation, increasing the potential for a greater flow of water into streams or rivers. Because precipitation and the resulting stream flow vary greatly from year to year and from storm to storm, watersheds have formed physical features to accommodate the variations of flow. In general, larger watershed have larger physical features to handle the precipitation. The main physical features used by streams and rivers to dissipate floods are called floodplains.

A floodplain is a strip of relatively flat land that borders a stream or river and is a part of the water channel created by floods. Floodplains are natural ways of dissipation floods; as water rises above the normal elevation in a stream or river, it flows onto the floodplain, where it spreads out, slowing the forces of the floodwaters.

As with floods, floodplains are classified according to frequency of flooding (once every 10, 50, 100, and 500 years). Because floodplains are infrequently floods and are relatively flat, they are desirable locations for development. Structural developments, such as houses, businesses, and factories have the largest potential for loss of life and property from flooding. Nonstructural developments, such as parks and farmland, have a lower potential for loss of property.

REDUCING THE IMPACT OF FLOODS

Human can reduce the impacts of floods through various structural and management methods. Structural methods include dikes and levees, flood-control reservoirs, and floodways. Dikes and levees act as walls that protect areas in floodplains; floodcontrol reservoirs store floodwaters temporarily and release them at a safe rate; and floodways divert floodwaters around certain areas.

Structural methods are designed to protect the area estimated to be inundated by a flood of a given recurrence interval. The extent to which structural methods protect an area depends on the flood for which the structure were built.

Flood-management methods incorporate prevention and protection. Flood-warning systems warn people of coming floods. Controlling the type and amount of development in a floodplain through zoning allows floodwaters to spread out without destroying property.

Where major development has already occurred in a floodplain, management methods are limited, and protection from flooding must rely upon structural methods.

IMPORTANCE OF WATERSHEDS IN FORESTRY

- 1. Twenty percent (20%) of world's freshwater flows out of Canada's forested watersheds.
- 2. The impact of logging on watersheds is minimized by:
  - leaving strands of trees to reduce erosion and avalanche hazards;
  - maintaining buffer strips along streams;
  - replacing harvested areas immediately; and
  - properly designing roads and stream crossings.
- 3. Harvesting increases the amount of water that reaches the ground and flows into rivers and streams.

Reference: Canadian Council of Forestry Ministers.

ECOSYSTEM-BASED WATERSHED MANAGEMENT, GENERAL ACTION PLAN

- Complete the compilation and inventory of environmentally-significant areas, including wetland evaluation updates, throughout regional watershed communities for use by regional municipalities in their comprehensive planning documents in consultation with provincial and municipal partners. This activity will take priority given the upcoming changes to the Provincial planning system.

- Prioritize the completion of all 100 year floodline mapping and remapping projects for all area watercourses.

- Conduct an evaluation of groundwater discharge and recharge regimes in the watersheds to prioritize protection efforts in this regard for water quality and quantity management purposes. This evaluation will include investigations into the hydrogeologic and hydrologic functions of the various watersheds to assist in the development of watershed management plans.

- Prioritize all area watersheds for the completion of watersheds and subwatershed management plans (e.g. the Welland River as a first priority). These watershed plans will be prioritizep by the extent of water quality degradation and will include, among other matters, methods to restore and enhance natural resources, to prevent development from occurring in environmentally-significant or hazardous areas, and to monitor the effectiveness of implemented methods. These plans will be undertaken in consultation with all partners.

- Develop a priority list of natural areas which would benefit from the enforcement of fill regulations, initiate discussions with the partners, the municipalities in particular, to initiate the mapping and consultation process.

- Develop improved flood forecasting and storm advisory/warning systems for events along the riverine systems (e.g. Lake Erie and Ontario shorelines, which include systems to advise of potential erosion dangers during these events. Improve liaison with our municipal partners in the delivery of this Emergency Program by hosting annual Workshops to familiarize all partners with their roles and responsibilities during an emergency situation.

- Expand the annual Regional Workshops for municipal staff on the preventive programs, which include information on effective resources management approaches, plan input and review matters and fill, construction and alteration to waterways regulations and procedures, to include all of the partners (e.g. the public at large, politicians, developers, contractors, consultants, conservation clubs and special interest groups). These Workshops will be conducted in partnership with other resource management agencies.

- Develop a Communication Strategy for the 'preventive' programs which will serve to promote a greater awareness throughout watershed communities of local regulatory function and it's importance for the provision of a healthier environment in the Niagara Peninsula.

- Develop a Capital Projects Policy Manual which includes general design philosophies and guidelines, incorporating (bioengineering) protection options, to be used in Regional flood and erosion control projects.

- Develop a brochure/manual and Communications Strategy for the Regional advisory service programs to better inform watershed communities of the availability of these services which provides advice and guidance to the design of flood, erosion, and sedimentation control projects on private property.

THE KEYS TO SUCCESS - THE THREE "Cs" Commitment, Communication, and Co-oparation

Commitment

Preparation of an Implementation Plan to ensure the strategies and directions to become a reality.

Communication

Create a broader awareness of the full range of the programs and services and ensure that they are developed to meet the needs of both the natural environment and the public which is served by the organization or establishment. Actively share information on conservation approaches and philosophies.

Co-operation

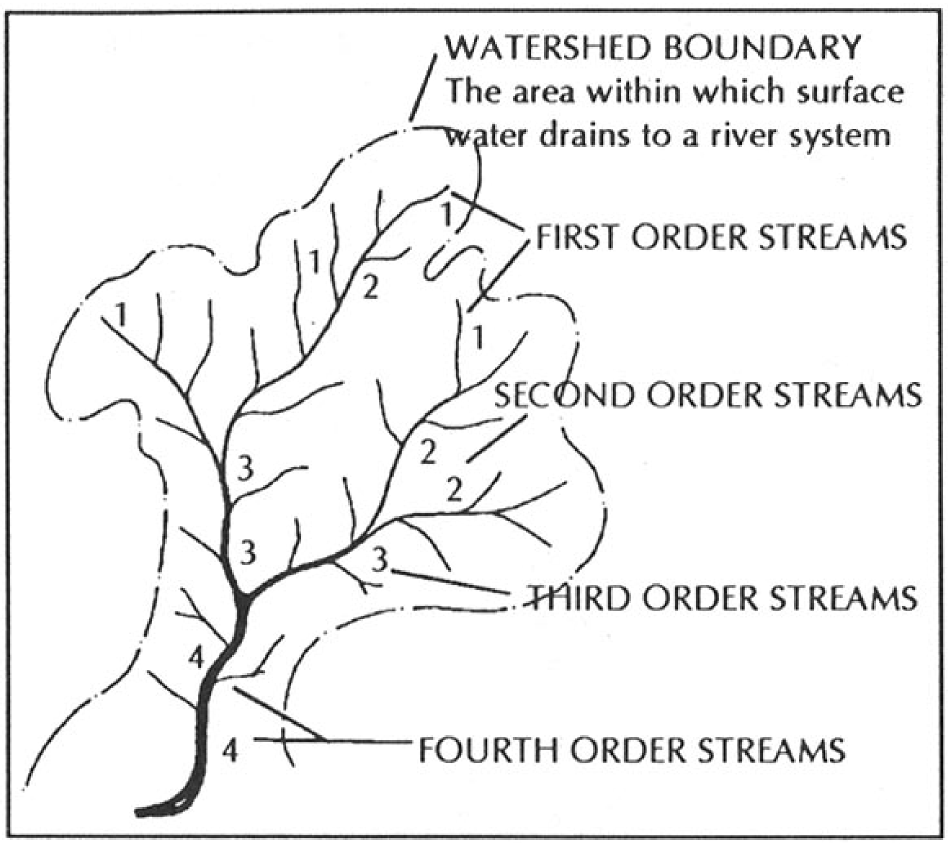
No one group can provide truly integrated resource management programs in the watersheds by itself. Co-ordination, consensus and partnerships to achieve common goals are required between agencies, all levels of governments, business, industry, clubs, special interest and environmental groups. Efforts should be made to forge new alliances in order to ensure the effective delivery of programs and resolution of environmental problems facing the region.

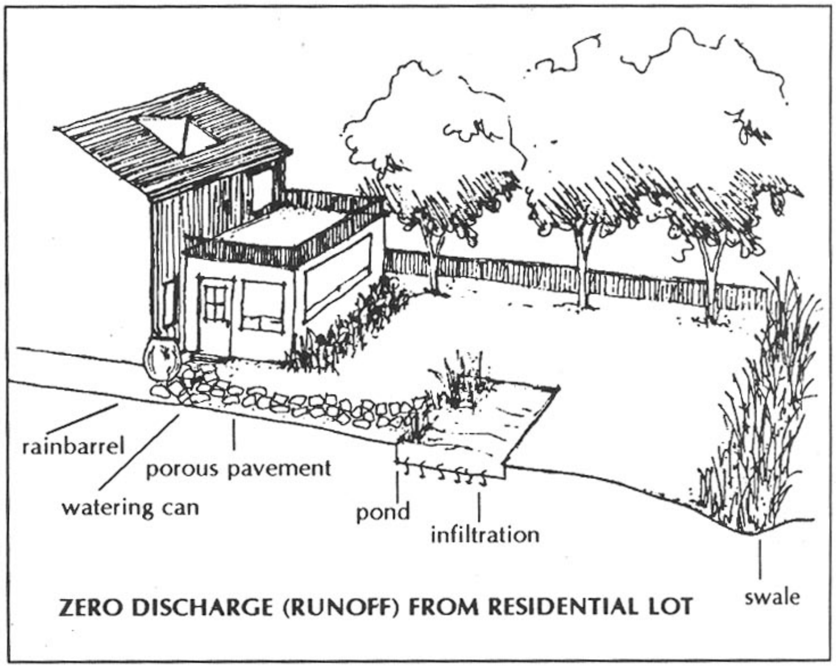
REFERENCES AND BIBLIOGRAPHY FOR FURTHER STUDY

- 1. Vandas, Steve, "Watersheds: Where We Live", Science & Children Vol. 34, No.7, April 1997, pp28-30.
- 2. The Watershed Conservation Strategy for the Niagara Peninsula Conservation Authority, Niagara Peninsula Conservation Authority, 2358 Centre Street, Allenburg, ON LOS 1AO, December 1994.
- 3. Regional Watershed Planning, Phase 1 Report, The Regional Municipality of Hamilton-Wentworth, Planning and Development Department, Regional Planning Branch, January 1992.
- 4. Integrating Water Management Objectives into Municipal Planning Documents, Ministry of Environment & Energy; Ministry of Natural Resources, June 1993.
- 5. Water Management on a Watershed Basis: Implementing an Ecosystem Approach, Ministry of Environment & Energy; Ministry of Natural Resources, June 1993.
- 6. Subwatershed Planning, an Interim Guide, Regional Municipality of

Niagara, Planning, April 1993.

- 7. A Bibliography of the Twelve Mile Creek Watershed, by Laura B. Fekete, Niagara Peninsula Conservation Authority, August 1996.
- 8. Forty Steps to a New DON, the Report of the Don Watershed Task Force, Metropolitan Toronto and Regional Conservation Authority, 1994.
- 9. Watershed Report Card, BRONZE level, Fishermen Involved in Saving Habitat, Southern Ontario Chapter, February 1996.
- 10.The Watershed Approach * Geographic Focus * Strong Science * Partnership, Environmental Protection Agency (EPA), United States, May 1997.
- 11.Watershed Approach Framework, EPA, US, June 1996.
- 12.Fretz, Laurie, "Yes IN My Back Yard" -- A guide to rehabilitating urban streams, The Conservation Council of Ontario, 506-489 College St. Toronto, On M6G 1A5, December 1992.

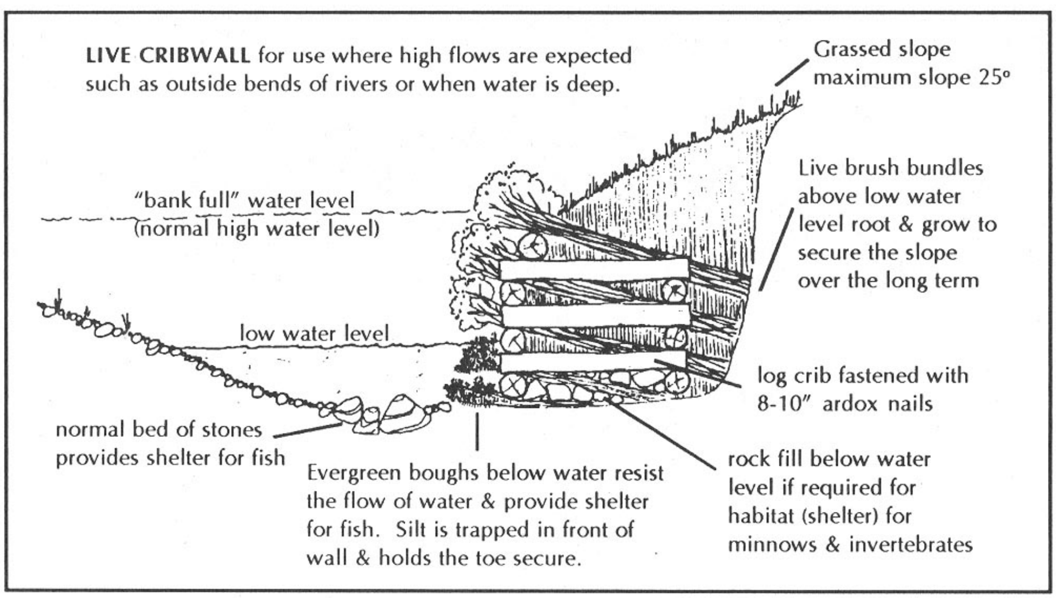




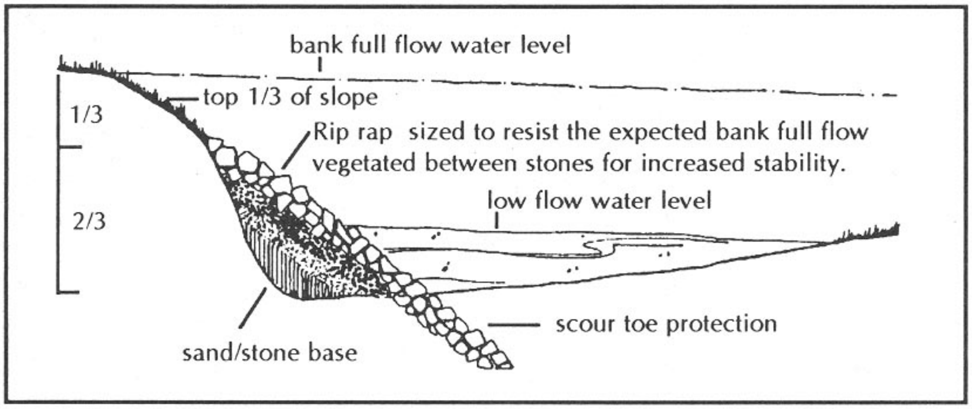
SOME EROSION CONTROL TECHNIQUES

BRUSH BUNDLES. Mainly used to narrow the stream channel. Log, trees, or other brush are anchored against the stream bank, forming a temporary barrier that traps sediment and material falling from the bank until vegetation can establish itself.

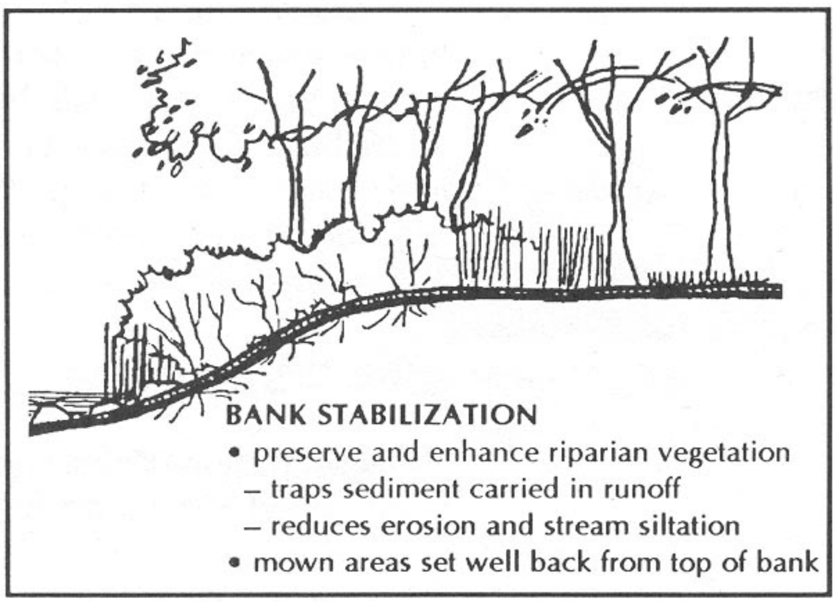
LOG CRIBBING. Logs are laid one on top of the other against the bank parallel to the stream flow direction. This protects the banks from erosion, slumping, and sedimentation.



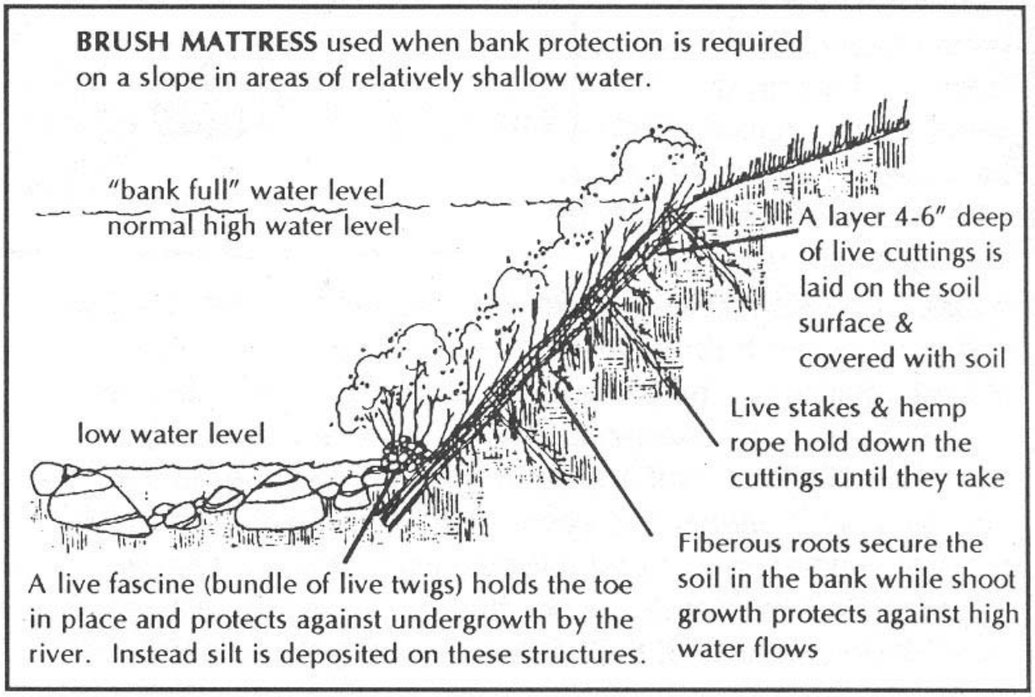
ROCK RIP RAP. In areas susceptible to erosion areas which require protection greater than can be given by vegetation cover, rock rip rap is the most common material used.

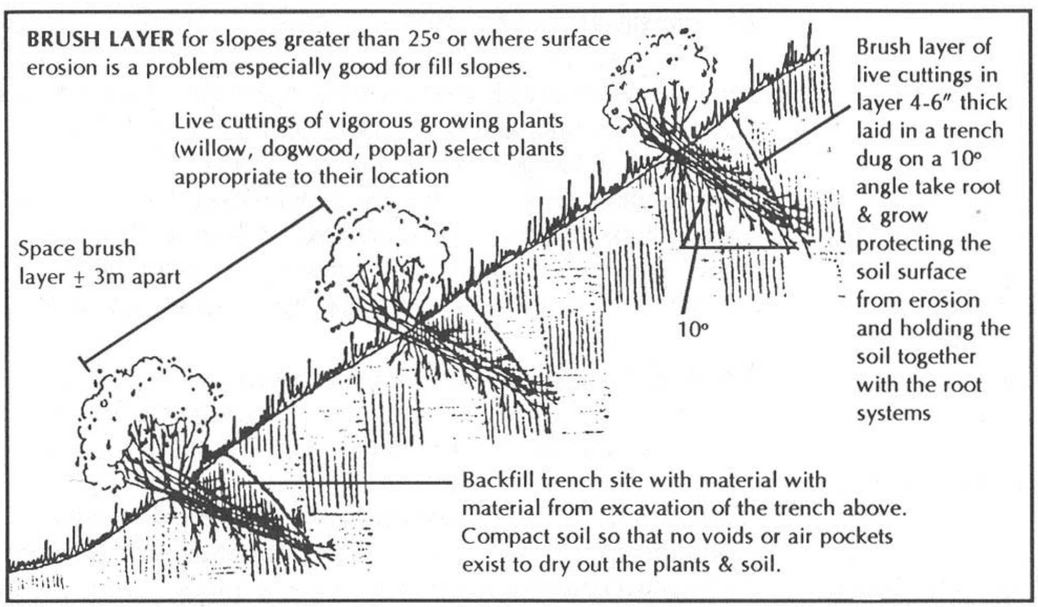


VEGETATIVE GROUNDCOVER. Vegetative groundcover can be used on its own; however, it is most effective when used in conjunction with other techniques. Grasses, legumes, shrubs, and trees are used to bind the soil particles together. The use of this method is determined by the severity and cause of the erosion.



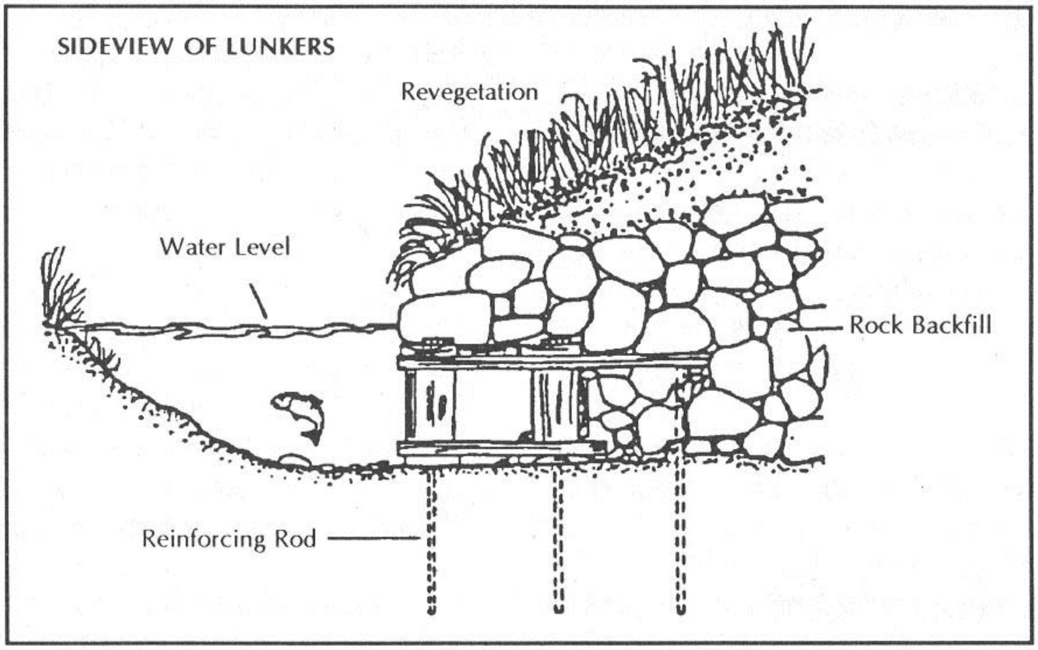
SOIL BIOENGINEERING. This is the process of using live plant cuttings to stabilize eroding banks. Method can be installed in early spring or fall. Two to three foot cuttings of usually of willow, dogwood, and poplar are planted into the side of a bank. These plants have a dense root system, and once established, will hold the soil together.



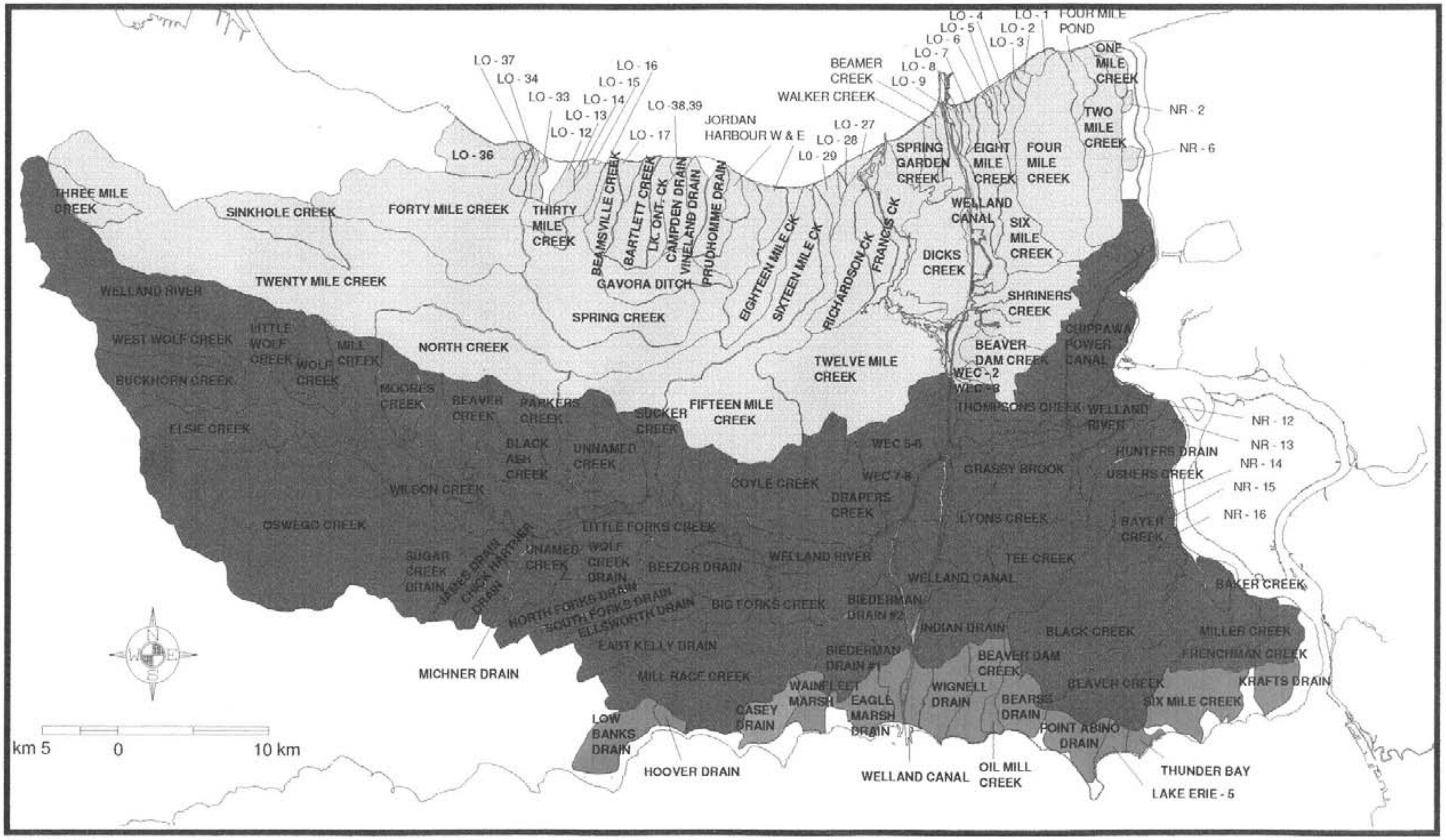


INSTREAM HABITAT CREATION

LUNKERS. A prebuilt habitat structure for fish. Within a stream environment fish need areas of pooling, riffle, and cover in order to survive and reproduce. Spaces are made from blocks of oak, obtained from short sections of tree trunks. Oak planks are nailed to the tops and bottom of the blocks, forming stringers that tie into the stream bank at right angles. More oak planks are then nailed to the top and bottom of the stringer boards. These boards parallel the stream bank. The entire structure forms a crib. The structure is anchored by driving lengths of reinforcing rod through predrilled holes in the structures and then into the streambed.



NIAGARA PENINSULA CONSERVATION AUTHORITY
SUBWATERSHEDS



LEGEND

- Lake Ontario Drainage Area
- Niagara River Drainage Area
- Lake Erie Drainage Area

NIAGARA PENINSULA CONSERVATION AUTHORITY