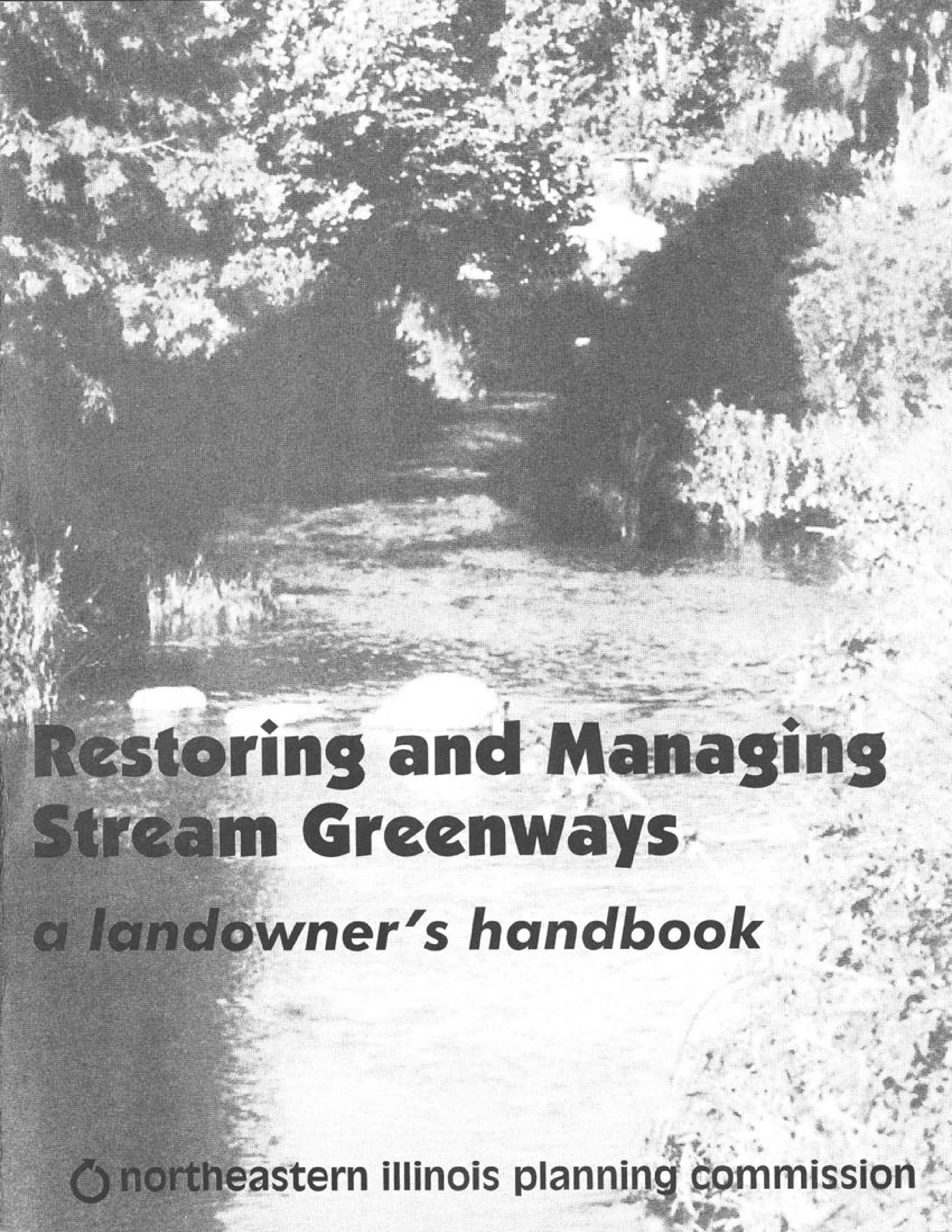

Restoring and Managing Stream Greenways

a landowner's handbook

northeastern illinois planning commission

northeastern illinois planning commission

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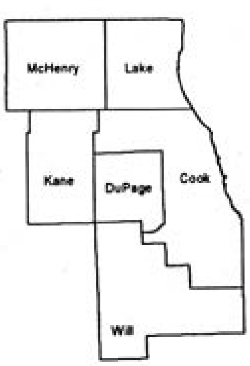
Northeastern Illinois is diverse in its land use and complex in its political structure. It has some of the most productive farms on earth-also one of the world's greatest cities. It contains 3,714 square miles of land and 38 square miles of water. It is home to 8.1 million people representing 65 percent of the total population of Illinois, and it is organized in more than 1,250 units of government.

In 1957, following a decade of rapid urbanization in the Chicago suburban area, the Illinois General Assembly created the Northeastern Illinois Planning Commission (NIPC) to conduct comprehensive planning for the six-county greater Chicago region.

The Commission has three statutory charges: conduct research and collect data for planning; assist local government; and prepare comprehensive plans and policies to guide development of the counties of Cook, DuPage, Kane, Lake, McHenry, and Will.

By necessity, regional planning deals with general development policies, not local land use detail. NIPC supports and coordinates county and municipal planning. The Commission has advisory powers only and relies upon voluntary compliance with its plans and policies.



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Restoring and Managing Stream Greenways: A Landowner's Handbook

prepared by
Northeastern Illinois Planning Commission
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for the
Chicago Region Biodiversity Council

CHICAGO WILDERNESS

A Regional Nature Reserve

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Chapter 1 Introduction

Background

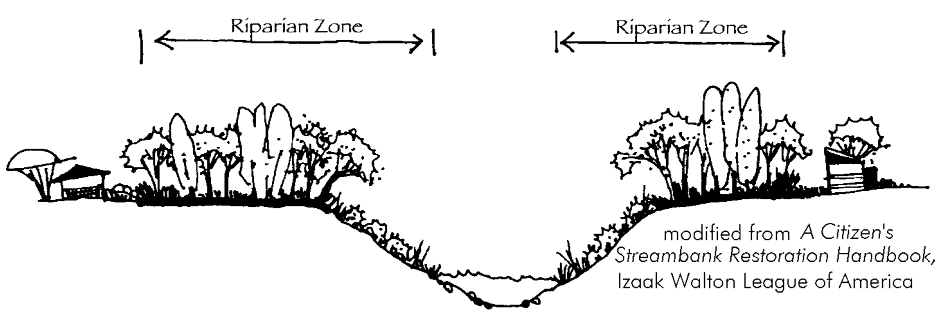
Streams and rivers are familiar features in the landscape of northeastern Illinois. They perform many important functions, some obvious and some not so apparent.

Drainage is their most obvious function. Streams convey runoff from the landscape, most noticeably during occasional floods when even the least conspicuous drainageway can become a raging torrent. Streams also convey the treated and untreated wastes of our urban and agricultural landscapes. In fact, virtually the entire flow in some of our more urban streams consists of treated wastewater during the drier times of the year.

Streams also are valued as recreational amenities because of their potential to support fishing, swimming, wildlife observation, and boating activities. Healthy stream environments provide habitat for diverse communities of fish, amphibians, insects, and aquatic plants. Stream and river corridors also are viewed as aesthetic amenities for residential development and public open space and provide travel corridors for wildlife.

Historically, however, conflicts have arisen between the various uses and functions of streams. In particular, increased reliance on streams as conduits for stormwater and wastewater has greatly diminished their ability to provide recreational, habitat, water quality, and aesthetic benefits.

There are two principal causes for use conflicts involving streams. The first is the alteration or destruction of the stream channel and its adjacent corridor, or *riparian* zone. Activities such as stream



modified from *A Citizen's Streambank Restoration Handbook,* Izaak Walton League of America channelization or straightening destroy critical habitat features and upset the natural balance between a stream and its floodplain that has evolved over thousands of years.

The second cause of stream use conflicts is the alteration of the watershed that contributes flow to a stream. A common example is the conversion of farmland to subdivisions and shopping centers and the corresponding increase in impervious land surface. This can result in adverse changes to both the quantity and quality of streamflow. These changes can consequently upset the natural equilibrium of a stream, often resulting in channel erosion, lost habitat, degraded water quality, and frequent flooding.

Purpose

To address these use conflicts, this handbook presents an approach for managing stream corridors which preserves and enhances their natural functions. Improved stream corridor management, in conjunction with better controls on watershed development, can substantially reduce the potential for stream degradation, loss of beneficial uses, and costly damages to property. Improved stream management techniques also can be used to reclaim degraded streams, restoring aesthetics, water quality, and aquatic life.

The recommended stream management approach uses low-cost, ecologically-sensitive techniques that are targeted to streamside landowners. This handbook addresses a range of common management concerns, including streamside landscaping, channel maintenance, and streambank stabilization. It provides a framework for improved stream corridor management but is not intended to be a definitive design manual.

Overview of Recommended Approach

The stream management approach recommended in this handbook embodies several inter-related principles.

- Effective management must address the stream and its riparian corridor as an integrated whole. The resultant stream *greenway*, a linear corridor of open land, can provide multiple, mutually-supportive functions, including habitat protection, water quality enhancement, flood storage and conveyance, and recreation.
- Techniques used for stream and river management systems must be *multi-objective*. Techniques designed for a single purpose, without full consideration of their effects on other functions, are destined to cause or aggravate stream use conflicts.
- Techniques used for stream protection or mitigation should be *sustainable*; that is, they should address identified problems without the need for excessive or costly future maintenance, and with minimal adverse effects on the surrounding environment.
- Stream corridor management should rely on *natural* techniques, wherever feasible. Natural techniques are derived from systems and materials that have evolved in nature over thousands of years. The techniques recommended in this handbook, such as soil bioengineering methods for channel stabilization or landscaping with native vegetation, often deviate substantially from conventional landscaping and engineering strategies.
- Recommended stream management techniques must be *cost-effective*. Considering the large network of stream channels in northeastern Illinois, the region generally can not afford expensive solutions. Low-cost techniques are more likely to be implemented by a higher percentage of streamside landowners.

In summary, the handbook provides alternatives to streamside property owners that will enable them to evaluate common stream management problems and opportunities from an ecologically sensitive perspective. In some cases, the landowners will be able to address their problems themselves using simple, low-cost techniques. In other, more complicated circumstances the handbook encourages landowners to seek professional assistance from resource agencies or private consultants.

The handbook is particularly applicable to the many ongoing efforts to establish and restore stream-based greenways. The *Northeastern Illinois Regional Greenways Plan*, developed by NIPC and the Openlands Project, identifies over 1,000 miles of stream greenways in the region. Stream greenways provide critical linkages to existing open space and natural areas, thereby enhancing biodiversity.

A Comprehensive Planning Strategy for Stream Naturalization

It is clear that after decades of being ignored and abused, the rivers and streams of the region are being seen as potential amenities. Stream corridors also are now recognized as critical linkages in restoring the integrity and biodiversity of the landscape and, ultimately, in enhancing the quality of life in the region.

Importantly, streams and other waterbodies are being viewed in the context of their watersheds. It is no coincidence that there is a growing network of watershed-based citizen stream protection and restoration initiatives in the region. These range from grass-roots groups, such as the Friends of the Chicago River, Friends of Tyler Creek, and DuPage River Coalition, to multi-jurisdictional initiatives such as the Ecosystem Partnerships for the Des Plaines, Fox, and Kishwaukee rivers, and other local government-based initiatives such as the Butterfield Creek Steering Committee. The Chicago Wilderness initiative is in the process of preparing a Regional Biodiversity Recovery Plan which when complete (projected completion date April 1999) will provide recommendations for stream restoration and management in this region in the context of the conservation of biodiversity.

A consistent element of all these initiatives is the awareness that local governments, developers, and landowners must treat the landscape with greater respect. In particular, there is a recognition that changes to the landscape are inter-related and that streams and rivers are reflections of the landscapes within their watersheds.

A sound planning approach that incorporates citizen and landowner interests is critical in accomplishing watershed and stream protection goals. Streamside landowners are encouraged to join forces with new or ongoing watershed and community-based initiatives in their area. Landowners, in addition to protecting and restoring their own section of stream corridor, can assist watershed initiatives in any of the following tasks.

- Participate as a stakeholder on a watershed committee.
- Support goals and objectives that embody progressive stream and watershed protection.
- Volunteer for stream inventory tasks, such as identifying areas of bank erosion or suspicious pollution sources.
- Support recommendations for more effective local government controls on new development to reduce stormwater runoff and limit infringement in stream corridors and wetlands.
- Help to implement the watershed action plan by joining in stream-cleaning projects and educating neighbors.
- Volunteer as a citizen stream monitor to track changes in water quality and aquatic life.

Handbook Overview

Stream ecosystem dynamics: The handbook describes some of the important natural functions of stream corridor ecosystems. Included are descriptions of watershed relationships, stream morphology, aquatic habitat, and riparian buffer systems.

Traditional management approaches and their consequences: The handbook briefly describes traditional single-purpose, "engineered" approaches to stream management and some of the adverse consequences to natural habitats and stream functions.

Natural management concepts: The rationale for the use of native vegetation and natural materials is described to serve as the basis for discussions of specific management techniques.

Recommended management techniques: Appropriate, ecologically-sensitive management techniques for addressing stream problems and for restoring natural functions are presented. These techniques include:

- streamside landscape buffers;
- stream channel maintenance;
- bank stabilization;
- instream habitat restoration; and
- accommodating trail access.

For each management technique, appropriate implementation and management considerations are addressed. Information on suggested plant lists, materials, relevant cost factors, and maintenance is provided, where available.

Chapter 2 Stream Management Principles

This chapter lays the groundwork for specific management techniques that follow in Chapter 3. It is important, particularly when considering innovative or uncommon approaches, to understand why they may be preferred over conventional methods. This chapter addresses this need by providing information on stream characteristics and ecosystem dynamics, traditional stream management approaches and their consequences, and the philosophy behind natural management concepts.

Stream Characteristics and Ecosystem Dynamics

When assessing a particular stream or stream segment, and particularly when considering how to manage that stream, it is important to understand certain basic stream characteristics. It also is important to recognize that a stream is a dynamic system which reflects its surrounding landscape.

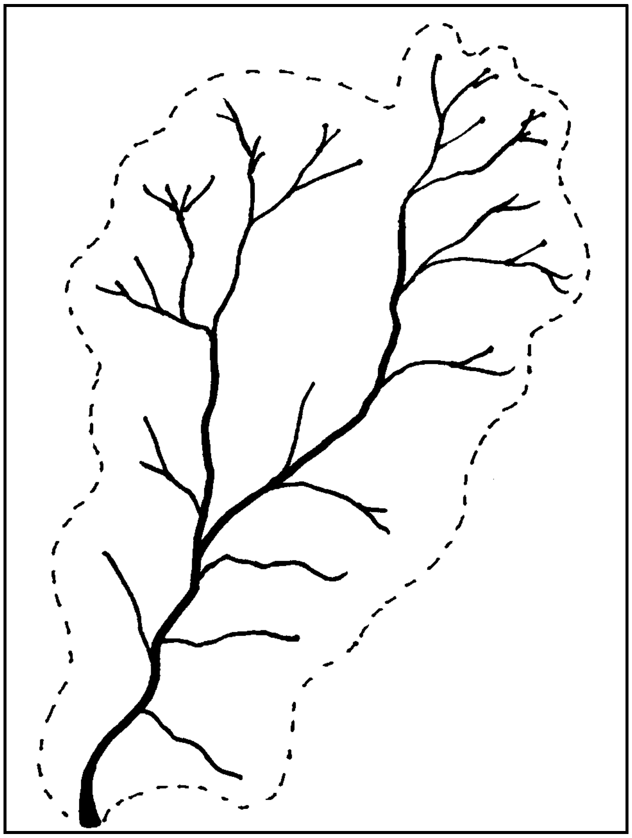
This section provides a brief overview of several fundamental aspects of stream function, including:

- watershed relationships,
- flow characteristics, or *hydrology*,
- channel structure, or *morphology*,
- water chemistry,
- aquatic habitat, and
- the floodplain/*riparian* zone.

Watershed relationships: First and foremost, a stream is a reflection of its watershed. A watershed is the land area that contributes flow to a stream. Watershed characteristics that are most important include size, topography, land use, and soils.

As described below, watershed relationships affect virtually every aspect of a stream. First, the watershed affects the amount and variability of flow that reaches a stream. This, correspondingly, affects the shape and size of the stream channel. The watershed also affects the quality, temperature, and chemistry, of runoff water reaching a stream.

Hydrology: Hydrology reflects the flow characteristics of a stream, particularly how flow quantity varies over time. Hydrology is principally



The watershed is the area inside the dashed lines and is the area drained by this stream system. From *A Citizen's Streambank Restoration Handbook*.

determined by the watershed. Larger watersheds contribute greater flows. The land use within a watershed also is important. Undeveloped watersheds consisting of natural woodlands, prairies and wetlands tend to absorb rainfall and produce relatively little surface runoff. The runoff that does occur reaches the stream at a fairly steady rate. Fish and other organisms, both plants and animals, historically found in Midwestern streams have adapted to such stable conditions.

In contrast, a developed watershed that absorbs less rain water, particularly an urban watershed, tends to produce large quantities of flow that reach the stream in erratic pulses. A stream channel responds to greater flows by attempting to deepen and enlarge its channel. The unfortunate consequences of urbanization include channel erosion and increased flooding.

Soils also are an important determinant of stream hydrology. If permeable soils, particularly sands and silts, are predominant in a watershed, then water can move freely through the soils and enter streams as subsurface flow, or baseflow. This condition tends to produce steady, stable flows. However, if watershed soils are predominantly tighter clay soils, less water can move horizontally through the soil and more must run overland or pond on the surface.

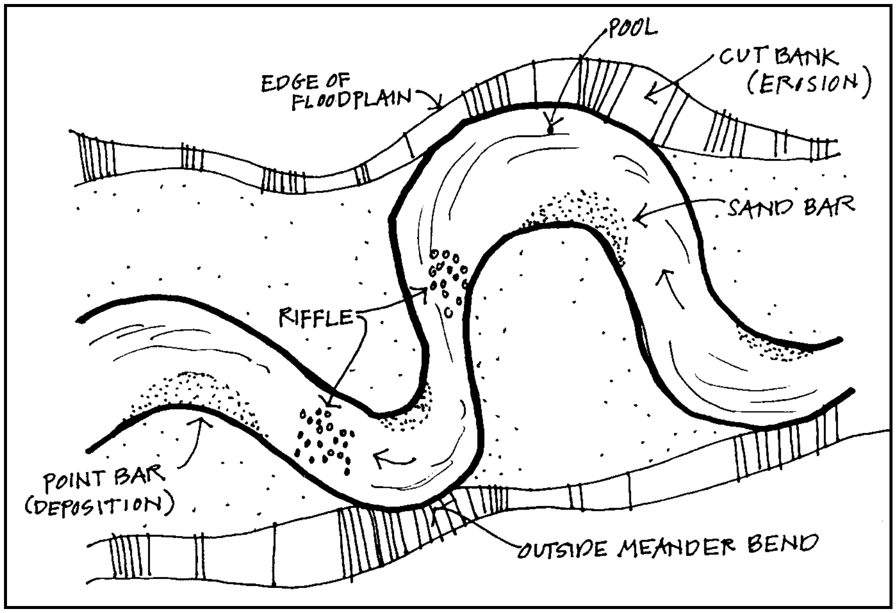
Climate is another determinant of stream flows in northeastern Illinois. While there is relatively little climatic variability within this region, our Midwestern climate clearly distinguishes local streams from those in the arid west or more humid south. This climate tends to produce relatively higher runoff and streamflow in spring and early summer, in comparison to fall and winter. This climate also is characterized by intense thunderstorms and occasionally severe snowmelt events, which produce large flow pulses in streams. This climate also produces occasional droughts which diminish stream flows, which is especially noticeable in intermittent headwater streams.

Channel structure—Morphology: Stream channel shape, size, and slope (or *gradient*) are all elements of channel morphology. Stream morphology is reflective of watershed characteristics, topography, and soil conditions.

Channel size is related to watershed size. Larger watersheds contribute greater flows, which consequently result in larger stream and river channels. Channel slope also tends to be related to watershed size. In general, northeastern Illinois streams and rivers with large watersheds tend to have relatively flat gradients. For example, a large river (like the Des Plaines) whose watershed area is several hundred square miles, typically drops only 2-3 feet over every mile of length. In contrast, many headwaters and tributaries that drain smaller areas tend to be steeper, typically dropping from 5 to 20 feet per mile, on average.

Channel slope, which also is related to topography, correspondingly influences channel shape. In general, the channels of flat-gradient streams tend to curve, or *meander*, more than channels of steeply-sloped streams. In either case, meandering is a natural phenomenon resulting from a stream's tendency to dissipate the energy of flowing water.

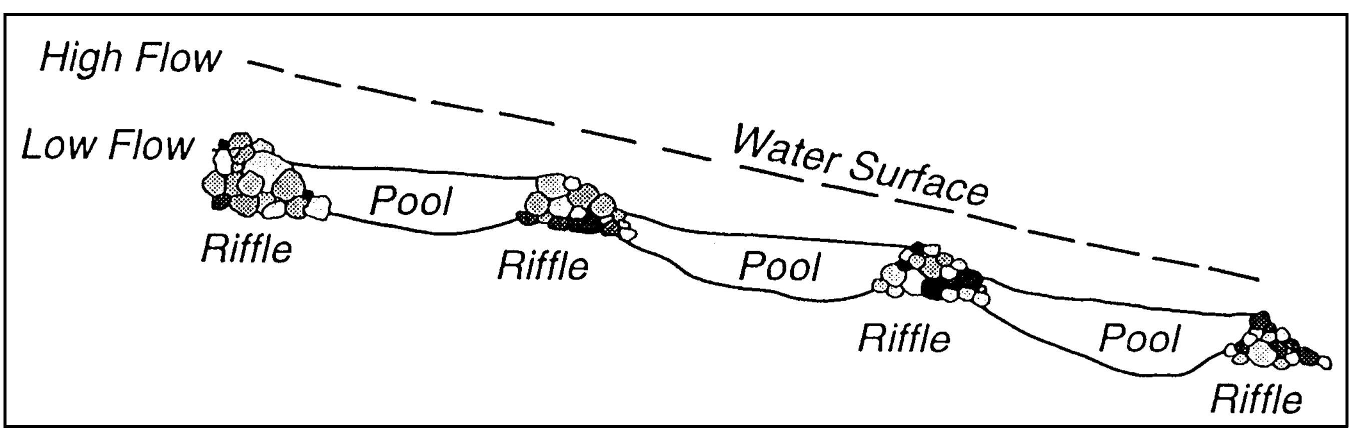
Surface soils and underlying deposits also are a determinant of stream morphology, as well as channel stability. Soils found adjacent to stream channels reflect the evolution of drainage patterns going back to the time of glacial activity thousands of years ago. While the predominant underlying soils in northeastern Illinois are clays, stream channel soils can be highly variable. Commonly, finer soils, such as silts, are likely to be found at the top of the streambank and coarser materials, such as gravels, are more likely on the stream bottom. Streams in some parts of the region are underlain by bedrock outcrops. Stream channel soils also are related to channel steepness. Streams with steeply-sloped channels tend to flow through coarse materials such as gravel and cobbles. This may reflect the fact that the channel has cut down over time through surface soils into underlying glacial materials. In contrast, flatter, slow-moving streams tend to flow through finer soils, including silts and organic wetland soils.



Plan view showing several aspects of stream morphology. From *A Citizen's Streambank Restoration Handbook*.

Morphology also establishes certain critical relationships between the occurrence of features such as pools and riffles, meanders, and channel width. In general, pools, the deepest zones in a stream channel, tend to occur at the outside bend of meanders. Riffles, the shallow, more turbulent zones in a channel, tend to occur in the straight portion of a channel, or "run," between meanders. It also has been determined in studies of numerous natural stream channels that the distance between meanders is directly related to average channel width.

Water chemistry: Another important stream characteristic is water chemistry. In a natural system, water chemistry indicators, such as pH, nutrient and organic content, and dissolved solids, are determined largely by watershed characteristics, principally soils. While there is not a great deal of natural variability in northeastern Illinois, it appears that some streams inherently carry higher concentrations of solids, nutrients, and organic matter than others. This may be related to watershed soil conditions. In a developed watershed, certain land uses, such as commercial and industrial areas, can significantly alter natural



Stream slope at high and low flow. From *Field Manual of Urban Stream Restoration*.

stream chemistry by generating high concentrations of nutrients, organic matter, and solids in stormwater runoff. This is called *nonpoint source pollution*. Water chemistry also is altered by the discharges of wastewater treatment plants that contribute *point source pollution*.

One of the most critical water chemistry factors is dissolved oxygen. In general, steep-gradient streams are likely to maintain higher dissolved oxygen levels than slow-moving, low gradient streams, due to the natural aeration provided by turbulence. Temperature is another important element of water chemistry. Stream temperature is most strongly affected by climate. Northeastern Illinois streams generally are classified, with few exceptions, as warm-water systems. This means that they can support fish such as bass but typically cannot support cold-water species such as trout. Water temperature also is affected by factors such as shading, flow depth, groundwater contribution, and watershed land use. For example, an urbanized watershed tends to produce higher summer stream temperatures due to surface runoff from sun-warmed parking lots and roads.

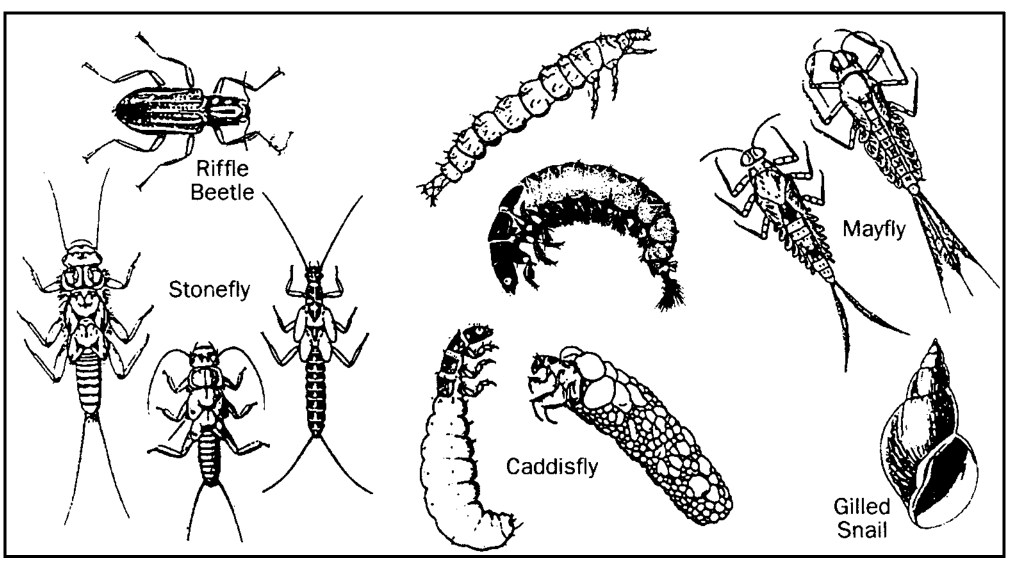
Aquatic habitat: Aquatic habitat includes all of those physical and chemical factors that determine the suitability of a stream channel for habitation by aquatic organisms, both animal and plant. Some of the most important physical habitat features are pools, riffles, bottom substrates, and cover. These features are important for various life-cycle functions of aquatic animals, particularly reproduction and feeding.

In general, a healthy stream ecosystem provides a diversity of habitats, including pools and riffles, submerged logs, channel vegetation, and a range of bottom substrates. Some organisms, for example, require water moving over coarse substrates such as gravels and cobbles. Other organisms generally prefer slower, deeper water moving over fine, organic substrates. These habitat needs also may vary over the various stages in an organism's life cycle. For example, fish fry will have different needs from adults.

Clean water and sediments also are prerequisites of healthy ecosystems. The presence of toxic compounds and/or very high turbidity levels will eliminate all but the most tolerant species of plants and animals. Similarly, excessive levels of sediment covering natural substrates will preclude many organisms.

In summary, a healthy aquatic habitat will support a diverse assemblage of fish, bottom dwelling (or *benthic*) organisms, and aquatic plants. Beyond their dependency on habitat, aquatic organisms also exhibit an interdependency on each other.

Riparian zone: The riparian zone is the land area immediately adjacent to a stream. While there is no specific determinant of the outer edge of the riparian zone, it generally includes areas which are normally dry but prone to occasional inundations by floods. Conditions within a riparian zone can vary widely. Commonly, natural riparian zones in northeastern Illinois will contain relatively moist soils at an elevation close to the stage of the river or stream. These areas are commonly classified as riverine wetlands. For some streams, however, particularly those with relatively steep gradients,

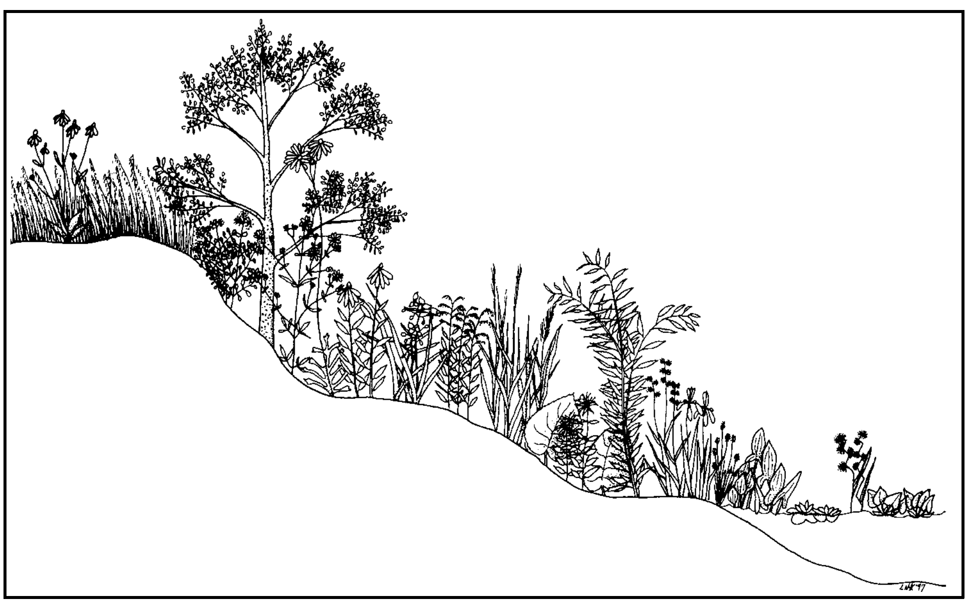


A selection of benthic macroinvertebrates. From *A Citizen's Streambank Restoration Handbook*.

the riparian zone may include upland areas that are relatively dry.

In a natural stream setting, the riparian zone exists in a state of dynamic equilibrium with the stream; that is, the riparian zone shifts in response to natural erosive forces and the tendency of a stream channel to slowly meander. From a stream management perspective, this is an important concept to recognize so that actions are not taken which will lock a stream into a set channel location.

From a management perspective, the most critical element in the riparian zone is vegetation. In a natural system, vegetation is determined largely by the factors described previously, principally soils, climate, and hydrology. Assessments of vegetation conditions prior to settlement of this region by Europeans indicate that most streams were bordered by herbaceous vegetation, principally prairie and wetland plants. This was due, in part, to the influence of fires which swept across the flat prairie landscape. Woody vegetation was found in some riparian environments, principally along the larger rivers and along the eastern edges of rivers and streams that were less susceptible to the effects of fire. Woody vegetation also was found along many of the steeper, ravine-like channels which predominate in some parts of the region.



A profile of the riparian zone. From *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois*.

Riparian vegetation varies directly with soil moisture and inundation frequency. In the zone which contains the stream channel and the lower edges of streambanks, only water-tolerant vegetation—such as rushes, emergent wetland plants, and moisture-loving grasses—is likely to exist. In larger rivers which produce very extended durations of inundation, the banks and channel edges may be dominated by bare slopes and exposed gravel or sand bars. Higher up the stream bank and into the floodplain, where inundation is less frequent, other grasses, sedges, and woody vegetation is likely to be found.

Summary: All of the preceding factors combine to determine the conditions found in a given stream or stream segment. While healthy stream systems are relatively stable over time, their various components are dynamic, exhibiting variability in flow, temperature, and water chemistry. Even the physical characteristics of stream channels are dynamic, as channel shape and dimensions slowly evolve in response to long-term changes in watershed characteristics.

While streams are dynamic, their characteristics within a natural, relatively undisturbed watershed reflect a stable, predictable state of equilibrium with their surroundings. Correspondingly, stream biota—including fish, bottom-dwelling organisms, and aquatic vegetation—have evolved and adapted over thousands of years to this state of equilibrium. Unless the characteristics described above are substantially altered, streams will continue to function as stable, diverse and productive ecosystems.

Historical Stream Management Approaches and Their Consequences

Since the arrival and dispersal of immigrants began 150 years ago across the northeastern Illinois landscape, many of the natural characteristics of stream ecosystems have been radically altered. These changes are the result of two principal activities: 1) development of upstream watersheds; and 2) direct, physical alteration of streams, floodplains, and riparian wetlands. While it may be difficult to determine which of these activities has had the most significant effects, there can be little disagreement that the cumulative impacts have been dramatic. The general consequence of these activities has been a reduction in stream stability and health. For example, it has been observed that virtually all of the region's streams in urban and suburban watersheds are moderately to severely degraded with respect to aquatic life. Other observed impacts include increased flooding, more rapid fluctuations in water levels, accelerated streambank erosion, and degraded aesthetics.

Watershed development impacts: Watershed development impacts have predominantly affected the quantity and quality of flow reaching streams. Because this handbook is directed principally to the management of the stream channel and riparian zone, watershed concerns will not be discussed at length. However, it is important in evaluating stream management techniques to have a good general understanding of watershed-related factors.

Probably the most important watershed consideration is how development activities, particularly urbanization, have substantially changed the hydrology of receiving streams. Flow arrives in higher volumes and in much more erratic rates than under natural circumstances. Consequently, urban streamflows are commonly described as "flashy." As a result, most stream channels have widened due to erosion to expand their capacity. Subsequent effects include shallower flows and elevated water temperatures. Fortunately, stream management techniques can address some of the hydrologic consequences of watershed modification, and thereby improve the stability and function of degraded stream channels. However, it must also be recognized that stream channel management may be only partially successful if the upstream watershed is continuing to be modified.

Similarly, watershed development has substantially impacted water quality in many streams. Some of the most common effects include lowered dissolved oxygen levels due to increased concentrations of organic matter; excessive growth of algae and nuisance aquatic plants (called *eutrophication*) due to elevated concentrations of nutrients; reduced water clarity; and sedimentation of stream bottoms. To varying degrees, the utilization of holistic stream corridor management and restoration techniques can reduce the consequences of these watershed-induced changes.

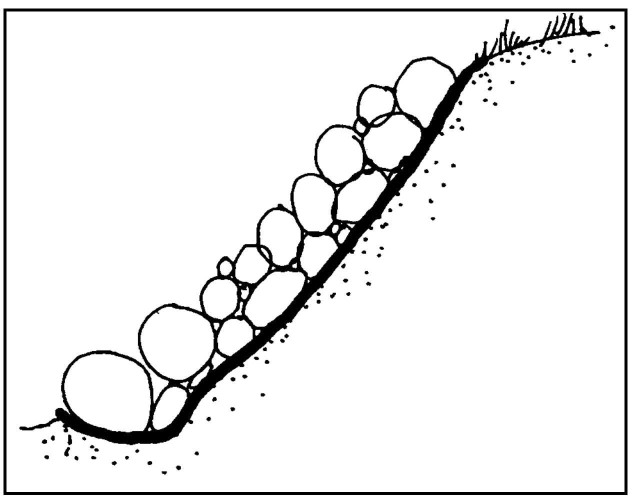
Physical alteration of stream channels and floodplains: Streams and floodplains have been altered historically for a number of reasons: to improve the utility or economic use of riparian lands and floodplains; to reduce adjacent and upstream drainage or flooding problems; and to change the aesthetic character of the riparian zone. The purposes of modifications, and the stream management techniques that evolved to accomplish them, often were justifiable within their historical context. However, it also is apparent that the adverse consequences of many historical modifications typically were either not understood or were considered to be of lesser importance than their intended economic objectives.

Several common types of channel and floodplain modifications are discussed in this handbook:

- channelization;
- channel armoring;
- elimination of native vegetation;
- channel maintenance;
- impoundments; and
- floodplain filling.

Channelization involves the straightening, deepening, and/or widening of a stream channel, generally for the purposes of increasing channel conveyance and/or draining adjacent land. One of the most extensive applications of channelization was performed by farmers and drainage districts to "improve" wet areas adjacent to streams for farming. Streams, particularly headwaters, were routinely straightened and deepened to increase drainage of both surface (via lateral ditches) and subsurface (via field tiles) water. Often, stream banks also were built up with berms or levees to keep routine floods out of farm fields. While such activities provided tremendous benefits to farmers and consumers, they also increased the quantity of runoff, lowered water tables, destroyed wetlands, and eliminated stream habitat features such as pools, riffles, and meanders.

The stream modification activities initiated by farmers have been expanded and magnified in urban areas. Channelization in urban areas has been performed to enable development of floodplains and riparian wetlands, and to reduce local flooding problems. In total, well over 40 percent of the stream miles in northeastern Illinois have been channelized. The unintended consequences of channelization include the destruction of aquatic habitat and increased downstream flooding, channel instability, and streambank erosion.



Riprap placement along a stream channel. From *A Citizen's Streambank Restoration Handbook*.

Channel armoring often accompanies channelization, particularly in urban settings. Armoring is accomplished with materials such as riprap, gabions, steel pilings, or concrete. Armoring is done to attain two principal purposes: to stabilize exposed streambanks, and/or to speed the flow of water by smoothing the surface of the channel.

The adverse effects of channel armoring are similar to those of channelization. An additional repercussion is the replacement of a vegetated streambank with a hard edge. As a consequence, the benefits of streambank vegetation, particularly its habitat for aquatic insects and amphibians and its shading effect, may be lost. The severity of the effect of armoring depends on whether the entire channel is lined (e.g., as in a small stream application) or armor is applied only in scattered locations (e.g., as in a larger river). The degree of impact also depends on the specific armoring technique used. Concrete lining, which produces an unnaturally smooth surface, eliminates nearly all desirable aquatic habitat features. Use of riprap, particularly in combination with native vegetation, can partially reduce the adverse ecologic effects by providing for some of the habitat needs of fish and benthic macroinvertebrates.

Other adverse ecologic consequences of some armoring installations are caused by the resultant increase in stream velocity. Excessive velocities can flush out bottom-dwelling organisms and lead to increases in channel erosion downstream of the armor installation.

Elimination of native vegetation from streambanks has occurred both directly and indirectly. Substantial vegetation losses have occurred due to the planting of non-native turf grass on streambanks for landscaping purposes, and as a result of stream maintenance activities (see below). Native vegetation also has been lost more gradually as aggressive non-native species, such as reed canary grass or common buckthorn, have invaded areas disturbed by channelization projects. The elimination of natural fires also has favored the spread of non-native plants. The consequences of these activities include streambank instability due to the loss of stabilizing vegetation and root systems; increased temperatures due to a combination of reduced shading and wider channels; and reduced habitat for aquatic insects, amphibians, and fish.

Channel maintenance activities generally are performed to enhance and maintain the ability of a stream channel to convey floodwaters in urban settings or to maintain surface and subsurface drainage capacity in adjacent agricultural fields. Maintenance commonly involves the removal of small trees and brush, larger stumps, and instream debris. If limited principally to excessive instream debris, stream maintenance should have little adverse effect on stream ecology. However, if maintenance includes the extensive removal of native streambank vegetation, ecologic consequences can be severe, as described above. An additional adverse consequence is the elimination of natural instream debris which is important as fish cover.

Onstream impoundments are constructed for purposes of stormwater detention, flood control, and recreation/aesthetics. The significance of their impacts depends on whether a permanent pool is created or the impounding structure stores water only during flood events. Permanent pools can have substantial adverse habitat and water quality impacts, particularly if the impounded stream is enriched with nutrients and organic matter (e.g., from urban runoff). Permanent pools encourage the accumulation of sediment, the growth of excessive populations of aquatic plants and algae, the elevation of water temperatures, and the occasional reduction of dissolved oxygen levels.

Dams also can seriously constrain the migration of fish and other aquatic organisms, thereby limiting access to headwaters for spawning and limiting the repopulation of areas that have been chemically or hydrologically disturbed. Instream impoundments also alter fish habitat, changing a stream segment from a riverine to a *lacustrine*, or lake-like, environment.

Floodplain filling generally has been done to accommodate new development, including roads, buildings, and parking lots. If filling occurs in the riparian zone close to the stream channel, it is likely to have significant adverse effects on the stream. Alteration of natural riparian environments can degrade aquatic habitat and reduce the pollutant-filtering effect of the riparian buffer, leading to degraded water quality. Further, filling or construction in riparian areas can increase nearby flooding and limit the opportunity for the stream to meander naturally over time.

In summary, it is known that much of the stream network in northeastern Illinois has been modified by channelization, bank armoring, vegetation removal, and impoundment. It also is known that many traditional stream and floodplain management approaches have caused serious collateral stream degradation, either locally or downstream.

Natural Stream Management Philosophy

The preceding observations lay the groundwork for alternative approaches to managing streams and their riparian corridors. At their core, the recommended approaches incorporate a "design with nature" philosophy, relying extensively on the use of native vegetation and natural materials. The recommended management approaches also are based on four previously stated principles:

- Stream channels and riparian corridors should be managed as an integrated whole, or *greenway*;
- Stream management techniques should not be designed for a single purpose but, instead, should be *multi-objective*;
- Management measures should be *sustainable*, with minimal environmental effects and minimal requirements for excessive or costly maintenance;
- Recommended techniques should be *cost-effective* to maximize their implementability on a broad regional scale, particularly by individual landowners.

This philosophy can be accomplished by considering the following guidance.

Emulate natural stream systems: As previously described, stream dynamics are based on relatively well-understood principles. When considering techniques for stream management, whether for protection of existing high quality streams or restoration of degraded or unstable systems, much can be learned by observing what "works" in nature. It is recommended that project designs reflect the conditions of similar streams in the same region as the project site which are stable and functioning well.

Take advantage of the benefits of native vegetation: One of the most important observations of stable, relatively undisturbed streams is the type of native vegetation found on streambanks and riparian areas. Because native vegetation is adapted to the soils and hydrologic conditions found in stable stream corridors, it is likely to adapt well in restoration applications. Equally important, native vegetation provides critical functions such as aquatic habitat and pollutant filtering. Native vegetation also is typically deep-rooted, thereby providing better streambank stabilization than introduced species like Kentucky bluegrass.

Be realistic in designing projects and setting objectives: While the ultimate goal of any stream protection or restoration project would be to replicate the characteristics of an undisturbed, exceptional-quality stream, this will rarely be possible in northeastern Illinois. Virtually every stream system has been altered to some degree by previous channel and/or watershed modifications. Therefore, the recommended objective of management and restoration efforts should be to maximize the beneficial *functions* of the stream system within the constraints of historical and ongoing disturbances. For example, rather than selecting a broad array of native plants, including rare and sensitive species, for an urban streambank stabilization project, begin with a shorter list of hardy native species which are tolerant of unstable hydrologic and water quality conditions.

Be patient in evaluating results: Natural methods may take longer to become fully effective than some conventional stream management techniques. This is particularly true for many native wetland and prairie plants which spend most of their energy during their early stages of development establishing a supportive root structure rather than above-ground growth. In contrast, shallow-rooted non-natives put most of their energy into above-ground growth. The investment in extensive root systems makes native plants more stable and tolerant of stressful conditions than most non-native species in the long run.

Design to accommodate potential "competing" uses: Streams, by definition, have multiple uses. Some of these uses, particularly in urban watersheds, may sometimes conflict. For example, stream maintenance to enhance conveyance has traditionally relied on the extensive removal of riparian vegetation. Destruction of riparian vegetation, though, can impair aquatic habitat and destabilize streambanks. Therefore, stream managers must identify long-term solutions, such as the use of low-resistance native grasses and sedges, that will minimize such conflicts.

Suggested References

A Citizen's Streambank Restoration Handbook, Karen Firehock and Jacqueline Doherty, Isaac Walton League of America, January 1995.

Restoring Streams in Cities: A Guide for Planners, Policymakers, and Citizens, Ann Riley, Island Press, 1998.

Stream and Wetland Protection: A Natural Resource Management Priority in Northeastern Illinois, D.W. Dreher, R.D. Mariner, and C. Hunt, Northeastern Illinois Planning Commission, 1988.

Urban Runoff Impacts to Receiving Waters, U.S. Environmental Protection Agency, Region 5, 1991.

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Chapter 3 Recommended Management Techniques

This chapter presents ecologically-sensitive management techniques for protecting, managing, and restoring stream greenways. These techniques address:

- Streamside landscape buffers
- Stream channel maintenance
- Streambank stabilization
- Instream habitat restoration
- Accommodating trail access

For each technique, a range of implementation considerations will be addressed, including design and installation techniques, maintenance needs, and costs factors. Case studies also will be presented, where appropriate.

Implementation Considerations

While this handbook attempts to provide the rationale and guidance for alternative approaches to improved stream corridor management, it is not intended to be an exhaustive reference or a definitive design manual. Readers are urged to consult the references included in each section for more in-depth guidance. Readers also are encouraged to contact the resource agencies listed at the end of this handbook for more information and design guidance.

In many cases particularly for large or complicated projects resource agencies will refer interested landowners to consultants and contractors who have practical experience in designing and installing the recommended stream management techniques. Landowners are encouraged to seek out consultants with multi-disciplinary capabilities including engineering, landscape architecture, and ecology who have demonstrated experience with the types of non-traditional management approaches recommended in this handbook. Because many of the recommended methods are relatively new, some consultants in a given field may not yet have adequate experience in successful project design and installation.

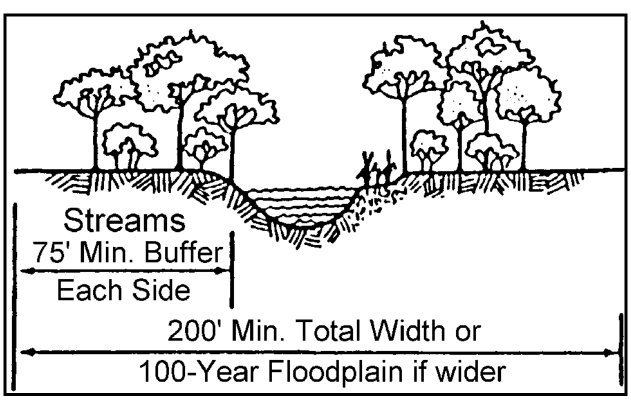
Qualified consultants also will be familiar with permitting requirements, an important consideration in some stream restoration activities. For any activity involving the physical modification of a stream channel or floodplain (e.g., grading or excavation), it is likely that a permit will be needed from the U.S. Army Corps of Engineers, the Illinois Department of Natural Resources/Office of Water Resources, and/or the local municipality or county.

3.1 Streamside Landscape Buffers

The Buffer Concept

The concept of a buffer is fairly simple. A buffer is a continuous vegetated strip of land comprised of the types of native plants which naturally exist in an undisturbed riparian setting. In contrast, a turf grass lawn down to the water's edge is not a buffer strip.

Buffers require little maintenance. In particular, the use of fertilizers is unnecessary, and pesticides should not be needed once the buffer is well-established. Buffer strip characteristics can vary depending on the stream or river setting. A buffer may be forest, prairie, or wetland. It may be 25 feet wide along a small headwater stream or hundreds of feet wide along a larger river. Most intrusions into the buffer are discouraged, but flexibility should be provided to allow appropriate user access.



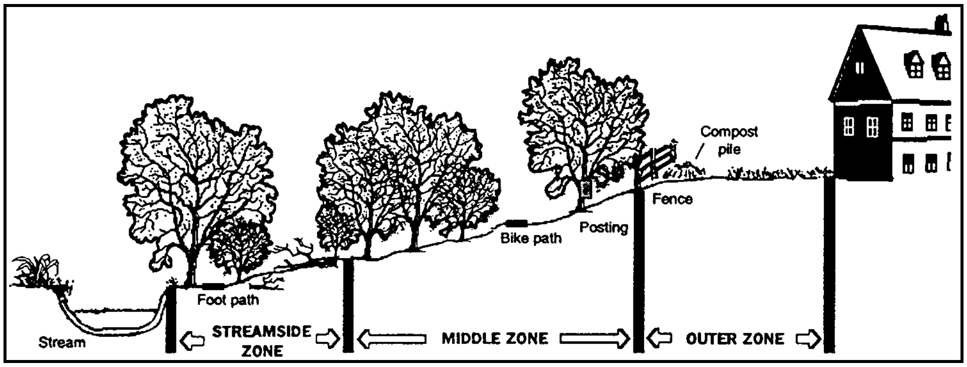
Stream buffer example from Dane Co. Wisconsin.

Rationale and Benefits of Natural Buffer Strips

Ecologists, water quality specialists, land planners, and stream managers all agree that a naturally vegetated buffer strip along the periphery of a stream or river is critical to the health and quality of the waterbody. A stable buffer is the last line of defense for forces that may seriously threaten a healthy, stable stream system.

Channel stabilization: Perhaps most importantly, a naturally vegetated riparian buffer lends stability to streambanks, warding off the erosive effects of high flow velocities and fluctuating water levels. This is accomplished by the soil-binding effect of a healthy root system and the deflection of erosive flows by lush above-ground growth.

Fish and wildlife habitat: Riparian buffers are essential to maintaining natural biodiversity in a stream corridor. Most importantly, a stream edge buffer provides critical habitat for fish and various aquatic insects, helping to maintain a balance in sensitive aquatic ecosystems. Riparian buffers also provide a transition zone between terrestrial and aquatic habitats, which is necessary for the survival of a number of birds, mammals, and amphibians. If sufficiently wide, riparian buffers also provide a connecting corridor for the migration of animals between larger open spaces.



A zoned buffer system, from *Site Planning for Urban Stream Protection*.

Runoff filtering: A vegetated buffer filters runoff generated by surrounding land uses, removing or mitigating the effects of harmful chemicals, nutrients, and sediments before they can reach the stream.

Shading: Depending on the width of the stream and the type of vegetation used, buffers can provide substantial shading. Shading is important to keep stream water temperatures cool in the summertime and may help to limit nuisance growths of algae.

Noise screening: Buffers can enhance the quality of stream and river recreational uses by filtering out the noise associated with certain types of adjacent land uses. Forested buffers, where appropriate, can effectively intercept noise from adjacent highways and industrial operations.

Preservation of aesthetic values: Streamside property owners have varying senses of what is appropriate streamside landscaping. However, most will agree that "natural" is better than "artificial." Even a narrow buffer can enhance the view across a stream or river. More substantial buffers can effectively screen the clutter of surrounding urban developments.

Buffer Design

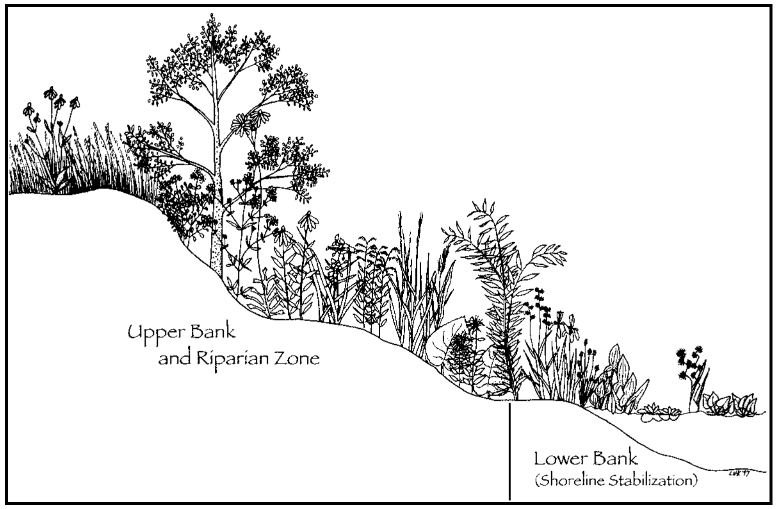
Buffer characteristics can vary widely depending on local circumstances. However, there are several basic components of any buffer.

Width: Any width of native vegetation along the edge of a stream will provide some benefits. However, it is recommended that a buffer extend a minimum distance of 25 feet from the edge of the water, or what is commonly called the "ordinary high water mark." Wider buffers—50 to 100 feet, or more—should be protected for larger and more ecologically-sensitive streams and rivers. The U.S. Department of Agriculture recommends "filter strips" of 66 to 99 feet for water quality protection. A recent national survey of local and state guidance for stream buffers observed a median width of 100 feet, with a range between 20 and 200 feet.

Intrusions: While a continuous, uninterrupted buffer is preferable for protection of water quality and habitat, some flexibility is desirable to provide access to the stream for recreational uses, particularly in parks and other public lands. Access typically would be provided via a mown footpath. Less intrusive pedestrian access could be provided via a stepping stone trail. Paving through a buffer is strongly discouraged, although limited intrusions may be acceptable to accommodate trail access.

Vegetation: It is recommended that buffers be planted with native species which are indigenous to a particular locale. The Federal Land Survey, conducted in the mid-1800s, provides a good general indication of the vegetation communities that existed prior to European settlement. It distinguishes between wetland, prairie, and woodland communities and provides a good indication of the type of vegetation which is naturally acclimated to the soils, hydrology, and climate of an area. It may surprise many landowners to know that most of the smaller stream and river corridors in the region were historically vegetated with wetland and prairie grasses and flowers, not trees.

In selecting plants for a buffer it should be noted that it is not necessary, or even feasible under most circumstances, to return the buffer zone to a pre-settlement condition. Rather, information on native riparian vegetation should be used as a guide to restore important *functions* such as bank stability and wildlife habitat.



Planting zones within a buffer. Modified from *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois*.

Buffer vegetation should begin at or below the normal water elevation with wetland species, and should proceed up the bank with water tolerant and upland species. Buffer vegetation also should reflect local needs and conditions. For example, a forested buffer may be appropriate if noise screening is desired but may not be appropriate if local residents desire an unobstructed view. Similarly, some property owners will prefer a greater mix of showy wildflowers, which may be less "functional" than other prairie plants but will enhance the beauty of the stream corridor.

A listing of suggested plant species which adapt well in urban and suburban stream buffers is provided at the end of this section. This list distinguishes between lower bank and upper bank zones. It also highlights several aggressive, invasive species which are undesirable in a riparian buffer. Species are considered undesirable if they crowd out more desirable species and they: 1) have limited soil-holding ability because of shallow root structure (like Reed Canary Grass), 2) provide little or no habitat value (like Purple Loosestrife), and/or 3) shade out understory vegetation (like Common Buckthorn). These undesirable species should never be intentionally planted in a riparian zone and steps should be taken to eliminate them if they already exist.

A much more thorough discussion of appropriate buffer species is provided in the *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois* (NRCS, 1997). This reference provides detailed information on individual plant characteristics as well as plant suitability under various hydrologic and water quality regimes.

Another suggested reference that should be useful to landowners considering the conversion of buffers to native plant communities is *The Tallgrass Restoration Handbook*. While it applies predominantly to upland environments and its advice is intended principally for "serious" restoration efforts, *The Tallgrass Restoration Handbook* nonetheless provides a wealth of current advice from practitioners who have successfully converted and restored natural landscapes in this region.

Finally, it also should be noted that the buffer recommendations contained in this handbook are intended for relatively basic streamside landscaping applications. Where there is a desire to implement a more complete restoration of a high quality riparian ecosystem, and hydrologic and water quality conditions are suitable, additional assistance should be sought from a trained ecologist.

Buffer Installation

There are two equally-important steps in establishing or restoring a buffer: site preparation and planting. However, the specific approach taken on a given site will vary depending on the size of the site and the conditions in the riparian zone.

Site preparation: Site preparation is critical to ensure that native vegetation has good growing conditions and is not overwhelmed by invasive species. One of several typical conditions may exist on a site prior to buffer installation: 1) the existing buffer is not regularly maintained and is overgrown with undesirable vegetation; 2) the buffer zone is vegetated principally with turf grass; or 3) the buffer is in a transitional state (e.g., from agricultural to residential) where bare soil may be predominant. Recommendations for each of these conditions follow.

If the buffer is ***overgrown with undesirable species***, buffer installation should begin with the removal of the unsuitable vegetation. Some of the most objectionable species are listed in the table at the end of this section. Possible techniques include cutting, mowing, burning, hand pulling, and herbicide application.

Cutting generally will be necessary for undesirable trees and shrubs. Sometimes it will be necessary to treat the stumps with a herbicide to prevent resprouting, particularly for species such as Common Buckthorn. Landowners should be aware that use of such herbicides (e.g., Garlon 4a) generally requires a licensed applicator.

Undesirable herbaceous species should be treated via some combination of mowing, burning, hand pulling, and herbicide application. The appropriate techniques for a particular site will depend on local conditions. Because native landscape restoration is an evolving field, even experts may disagree on the best approach for a given site. In general, if infestations are limited, hand pulling may be effective. Where infestations are severe, some combination of herbiciding and burning may be necessary. While this handbook recommends the use of herbicide as a possible alternative for several vegetation management situations, landowners should be very cautious and judicious in its use. In particular, in riparian environments care should be taken avoid to herbicide spraying in the stream channel.

If the buffer zone is ***vegetated principally with turf grass***, site preparation needs may be minimal. Some experts recommend herbicide application or removal of the sod layer to reduce competition with newly-planted native species. In some cases, shallow tilling may be appropriate. Tilling is discouraged, however, in riparian areas that are subject to frequent inundation or erosive water flow velocities. Also, it is important that exposed soil be quickly stabilized using temporary seeding, straw mulch, and/or other appropriate techniques.

If the buffer is ***in a transitional state and bare soil is predominant***, herbicide application still may be appropriate to reduce competition from emerging weeds.

Planting: Planting should be done immediately after site preparation is completed. Planting can be done with live plants and/or seeds.

Where project budgets allow, use of live plants, in combination with seeding, is preferable because it results in rapid establishment of vegetative cover. Live plants are particularly desirable on streambanks which are susceptible to frequent inundation. It generally is desirable to install most live plants in the spring or early summer to allow for effective root establishment before the following winter, although some species are best planted in the fall. Most trees and shrubs also can be planted in a dormant state in the fall.

Because most project budgets will allow for only limited use of live plants, seeding typically is used over the majority of the buffer zone. Where seeding is done, it is important to use a cover crop (see suggestions at the end of this section) to quickly establish a stable vegetative cover. Depending on the season, planting native vegetation seeds may be deferred until moisture and temperature conditions are appropriate. In general, most native plants should be seeded in the spring. As an alternative, dormant seeding may be done in the late fall or winter. The *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois* should be consulted for information on appropriate seeding techniques and conditions.

To prevent seeds and soil from washing away, several techniques should be considered. Where stabilizing root structures of herbaceous plants are already present, use of a no-till drill is recommended. Where bare soil is present, the seed should be raked into the ground and erosion blanket should be installed to maintain soil moisture and minimize erosion. In riparian areas where inundation is unlikely, mulch is a less-expensive alternative to erosion blanket.

If unusually dry conditions persist after planting or seeding, short-term irrigation may be necessary to prevent desiccation. Irrigation generally will not be necessary, however, if planting is done in the recommended seasons.

Buffer Maintenance

The most critical time for buffer maintenance is shortly after planting. During this period, herbaceous plant species are putting most of their energy into the establishment of root system, and relatively little growth may occur above ground. It is particularly important, therefore, to limit competition from aggressive, non-native plants. During this period, mowing and/or selected use of approved herbicides may be necessary to control weed species. When mowing to suppress weeds, practitioners generally recommend mowing high (e.g., 9 to 12 inches). If weed problems are particularly severe, it may be advisable to contact a professional landscape contractor familiar with native vegetation for advice.

Once the buffer is well established (typically within 1-3 years), maintenance will involve occasional mowing or prescribed burns to suppress weeds and maintain native plant diversity. Where site conditions permit, burning generally is the preferred maintenance approach because it is a natural process that rejuvenates native plant communities, particularly prairies and wetlands, and can effectively suppress weeds. However, burning requires an Illinois Environmental Protection Agency permit and should be conducted only by trained individuals.

If certain noxious weeds need additional control, limited use of approved herbicides may be appropriate in localized areas. Use of fertilizer is not necessary and should be avoided in the buffer strip.

Local Examples

The Chicago Botanic Garden in Glencoe recently created a twelve-acre buffer along a nearly one mile stretch of the Skokie River. The created buffer averages about 50 feet in width on both sides of the channel and consists of several "oxbow" wetlands and an evolving prairie community. The former landscape was dominated by Kentucky bluegrass and invasive weeds. Site preparation involved a prescribed burn in the spring to remove thatch followed by the application of herbicide (glyphosate) to kill emerging non-native vegetation. Initial prairie planting was done using a no-till drill technique to reduce soil disturbance and avoid activating the weed seed bank. A low-cost mix of annual rye and eight species of prairie grasses and forbs was seeded at a rate of 16 pounds per acre. This was supplemented by hand seeding an expanded array of native species in subsequent years. Wetland zones were planted by volunteers with live plants. While the buffer is still a work in progress, it has clearly transformed the landscape of the river corridor and greatly enhanced wildlife and water quality functions. This site is easily viewed from trails and roadways along the west side of the Garden property.

Contact: Joan O'Shaughnessy
Chicago Botanic Garden
1000 Lake Cook Road
Glencoe, Illinois 60022
847/835-8312

Citizens for Conservation (CFC), a non-profit citizens group based in the Barrington area, owns and manages several parcels of land. In 1996, it began restoration of a 1000-foot buffer along Flint Creek upstream of Route 22 in Lake Barrington on a site called the Flint Creek Savanna. The riparian zone was almost entirely dominated by Reed Canary Grass, a species that has become a troublesome invader of riparian zones throughout the area. Two techniques were used to eliminate Reed Canary Grass. Parts of the riparian zone were mechanically scraped, physically removing existing vegetation and the top six inches of soil that contained most of the root zone. Dormant seeding was applied to these areas in the fall. Remaining riparian areas were treated by successive applications of burn management and herbicide. Treated areas were planted by volunteers with plant plugs. Subsequent applications of a selective herbicide that does not harm sedges and forbs were made to eliminate Reed Canary Grass sprouts. Supplemental seeding and planting were done by volunteers early the following summer. Planted vegetation spread effectively, and by the end of the 1997 growing season the buffer was very well-vegetated with a diverse mix of native species, and there was almost no evidence of Reed Canary Grass. While long-term conclusions can not yet be drawn, the short-term restoration results are highly encouraging and visually striking. The rehabilitated riparian buffer is now an integral habitat component of the Flint Creek Savanna, blending with adjacent prairie, wetland, and oak savanna communities.

Contact: Tom Vanderpoel
Citizens for Conservation
P.O. Box 435
Barrington, Illinois 60011
847/462-0358 (at Savanna Landscaping Co.)

Suggested References

Landscaping Techniques and Materials for Urban Illinois Stream Corridors and Wetland Edges, R.D. Mariner and L. Mertz-Erwin, Northeastern Illinois Planning Commission, for the Illinois Department of Energy and Natural Resources, 1991.

Model Stream and Wetland Protection Ordinance, Northeastern Illinois Planning Commission, 1988.

Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois, USDA Natural Resources Conservation Service's Chicago Metro Urban and Community Assistance Office, in cooperation with U.S. Environmental Protection Agency, Region 5, U.S. Fish and Wildlife Service, Chicago Field Office, and U.S. Army Corps of Engineers, Chicago District, December 1997.

Natural Landscaping: A Sourcebook for Public Officials, Northeastern Illinois Planning Commission, May 1997.

Site Planning for Urban Stream Protection, T. Schueler, for Metropolitan Washington Council of Governments, December 1995.

Stream and Wetland Protection: A Natural Resource Management Priority in Northeastern Illinois, D.W. Dreher, R.D. Mariner, and C. Hunt, Northeastern Illinois Planning Commission, 1988.

Tallgrass Restoration Handbook, S. Packard and C.F. Mutel, eds., Island Press, Washington, D.C., 1997.

Suggested Plant Species Mixes

These lists are derived principally from the *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois*. The suggested plant species mixes are intended to provide landowners with an idea of species that could be used together in riparian and streambank zones. Selection of species for a given site should factor in local environmental conditions, such as soils, hydrology, and pre-settlement vegetation, as well as aesthetic considerations. Generally, it may be desirable to overlap planting of different species mixes given the varying, and sometimes uncertain, hydrologic regime in a given zone. It should be noted that the recommended species lists represent a limited diversity of plants, emphasizing those species that should be relatively easy to establish in *rehabilitating* modified riparian zones. For prairie, woodland, or wetland *restorations*, planting mixes should go beyond the species listed here.

Lower Bank (Streambank Stabilization)

Water Plantain	*Alisma subcordatum*
Fox sedge	*Carex vulpinoidea*
Hackberry	*Celtis occidentalis*
Common Buttonbush	*Cephalanthus occidentalis*
Gray Dogwood	*Cornus racemosa*
Red-Osier Dogwood	*Cornus stolonifera*
Blunt Spike Rush	*Eleocharis obtusa*
Creeping Spike Rush	*Eleocharis acicularis*
Nodding Wild Rye	*Elymus canadensis*
Virginia Wild Rye	*Elymus virginicus*
Green ash	*Fraxinus pennsylvanica*
Fowl Manna Grass	*Glyceria striata*
Common Sneezeweed	*Helenium autumnale*
Rice Cut Grass	*Leersia oryzoides*
Switch Grass	*Panicum virgatum*
Peachleaf Willow	*Salix amygdaloides*
Black Willow	*Salix nigra*
Chairmaker's Rush	*Scirpus americanus*
Late Goldenrod	*Solidago gigantia*
Prairie Cord Grass	*Spartina pectinata*
Blue Vervain	*Verbena hastata*
Nannyberry	*Vibernum lentago*

In severe erosion situations where the dormant stake method is appropriate, sandbar willow (*Salix interior*) may be recommended due to its aggressive behavior.

Undesirable Species

Box Elder	*Acer negundo*
Garlic Mustard	*Allilaria officianalis*
Tartarian Honeysuckle	*Lonicera tatarica*
Purple Loosestrife	*Lythrum salicaria*
Reed Canary Grass	*Phalaris arundinacea*
Common Buckthorn	*Rhamnus cathartica*
Glossy Buckthorn	*Rhamnus frangula*
Multiflora Rose	*Rosa multiflora*

Upper Bank and Riparian Zone

Big Bluestem	*Andropogon gerardi*
Smooth Blue Aster	*Aster laevis*
Panicled Aster	*Aster lanceolatus*
New England Aster	*Aster novae-angliae*
Common Beggar's Ticks	*Bidens frondosa*
Side-oats Gramma	*Bouteloua curtipendula*
Hackberry	*Celtis occidentalis*
Tall Coreopsis	*Coreopsis tripteris*
Gray Dogwood	*Cornus racemosa*
Red-Osier Dogwood	*Cornus stolonifera*
Nodding Wild Rye	*Elymus canadensis*
Virginia Wild Rye	*Elymus virginicus*
Green ash	*Fraxinus pennsylvanica*
Wild Bergamot	*Monarda fistulosa*
Switch Grass	*Panicum virgatum*
Purple Prairie Clover	*Petalostemum purpureum*
Common Mountain Mint	*Pycanthemum virginianum*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
Yellow Coneflower	*Ratabida pinnata*
Black-eyed Susan	*Rudbeckia hirta*
Little Bluestem	*Schizachyrium scoparium*
Compass Plant	*Silphium laciniatum*
Prairie Dock	*Silphium terebinthinaceum*
Stiff Goldenrod	*Solidago rigida*
Indian Grass	*Sorghastrum nutans*
Prairie Cord Grass	*Spartina pectinata*
Spiderwort	*Tradescantia ohiensis*
Common Iron Weed	*Veronia fasciculata*
Arrow-Wood Viburnum	*Viburnum dentatum lucidum*
Nannyberry	*Vibernum lentago*

Cover Crops

Annual Ryegrass	*Lolium multiflorium*
Smartweed	*Polygonum punctatum*
Yellow Coneflower	*Ratabida pinnata*
Black-eyed Susan	*Rudbeckia hirta*

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3.2 Stream Channel Maintenance

Rationale for an Improved Stream Maintenance Approach

Maintenance refers to those activities needed to preserve the capacity of stream channels to convey runoff, particularly during times of flooding, as well as the removal of debris to maintain a desired aesthetic character. In a natural, pre-development setting, intervention to maintain stream channel conveyance was unnecessary. Streams and their riparian corridors evolved gradually in response to natural phenomena such as beaver dams, prairie fires that limited the presence of woody vegetation along many streams, and the flushing effects of occasional floods. Because floodplains were not occupied by human activities, enhanced conveyance was of no concern.

Maintenance has become a necessary activity, however, in many developed watersheds. In agricultural settings, maintenance is needed to provide an adequate outlet for field tiles and to limit the time of inundation following floods. In urban areas, maintenance has become necessary to remove debris generated by human activities and to validate the assumptions commonly made by engineers in floodplain studies that flow will move in a relatively unimpeded manner. Unfortunately, most channel maintenance programs in both agricultural and urban areas historically have focused solely on drainage and have ignored the multiple functions of a stream channel. In particular, conventional maintenance commonly has resulted in the virtual elimination of desirable riparian vegetation and instream cover, particularly in headwater streams.

Recognizing that continued maintenance is necessary and inevitable, the challenge is to identify a better approach that recognizes both the natural functions and desired uses of streams.

A Sustainable Stream Maintenance Strategy

A preferred stream maintenance approach should include several basic elements:

- avoid storage or disposal of materials in riparian areas;

- maintain effective channel conveyance;
- perform maintenance on a routine, ongoing basis;
- preserve and/or restore native riparian vegetation; and
- preserve instream habitat features.

These elements are described below.

Avoid storage or disposal of materials in riparian areas: Materials stored or disposed in riparian areas may eventually find their way into the stream channel, causing subsequent conveyance and water quality problems. Materials to be avoided include landscape wastes, machinery or chemicals, and anything floatable. It is particularly important to avoid dumping yard waste along stream banks. This, unfortunately, is a common practice, sometimes based on the mistaken assumption that grass clippings and leaves will enhance streamside vegetation and help prevent erosion. In reality, such dumping typically kills underlying vegetation, leading to bank instability. Also, yard wastes washed away by high flows cause undesirable increases in nutrient and organic loadings in the stream.

Maintain effective channel conveyance: Maintaining effective conveyance requires attention to debris both within the channel and in adjacent riparian areas. It also may require management of excessive woody vegetation on channel banks.

Debris blockages that substantially impede flood flows should be removed, or at least partially breached. Such debris jams also can increase channel erosion by forcing streamflows toward unprotected banks. In deciding on a site-specific removal strategy, the degree of threat posed by the obstruction should be considered. In areas of high flood risk, a conservative strategy should be followed. In less-urbanized areas where flood risk is minimal, debris removal can be less rigorous. On all sites, all non-natural debris (e.g., construction material or trash) should be removed regularly.

Substantial debris in riparian areas outside the channel also should be removed to prevent its entry into the channel during flood conditions. Priority should be given to large floatable materials that have the potential to obstruct culverts.

While the historic practice of clear-cutting wooded stream channels is strongly discouraged, there is a need to manage excessive woody vegetation under some circumstances. In particular, trees whose roots are severely undercut should be removed, although their root wads should be left in place to provide bank stability. Invasive non-native trees, such as Common Buckthorn, also should be managed. Not only do such trees restrict conveyance, they also crowd out more desirable understory species to the point that the underlying ground surface may be barren. As a consequence, riparian habitat is destroyed and exposed banks are subject to serious erosion.

The stumps of Buckthorn and similar aggressive species must be treated with a herbicide to prevent resprouting. Several local contractors recommend the use of Garlon 4a, but it should be applied only by a licensed herbicide applicator. As an alternative, some local practitioners recommend the use of full-strength Round-up applied to the stump. Although this alternative does not require a licensed contractor, landowners always should be very careful in the use of any herbicide.

Whenever heavy equipment is needed to perform major maintenance activities, precautions should be taken to minimize environmental disturbances. In particular, heavy maintenance should be performed during dry seasons or during the winter when the ground is frozen. Also, wherever possible, heavy equipment should be operated from the top of the bank, avoiding bank slopes and channel bottoms. In larger streams and rivers, floating barges can be used to collect and remove debris. These precautions should minimize erosion and reduce the disturbance of sensitive aquatic habitat and native vegetation.

Perform maintenance on a routine, ongoing basis: One of the shortcomings of traditional maintenance programs is that they were performed very sporadically, typically once every 15 to 20 years. As a consequence, stream maintenance typically required the use of heavy equipment in fragile riparian zones, resulting in serious habitat destruction. A preferred approach is to inspect and maintain streams annually, or more frequently if dictated by unusual conditions such as large floods.

Routine inspections should be done to identify debris, obstructions, or nuisance vegetation. Inspections also should note areas of serious bank erosion. Maintenance should follow wherever problem areas are identified. If performed on a regular basis, the need for heavy equipment will be minimized. Homeowners and other small landowners should be able to accomplish most routine maintenance tasks without outside contractors or government agency assistance.

Preserve and/or restore *native* riparian vegetation: Indigenous native vegetation generally should be preserved. Native riparian vegetation provides important benefits such as bank stabilization and shading of the channel. Undesirable, invasive woody vegetation should be removed from channel banks and adjacent riparian areas. In its place, indigenous native species should be replanted and managed.

Before maintenance begins, a plan should be developed to identify vegetation to be removed, protected, or restored. The plan should be based both on the uses and conditions of the site as well as the pre-settlement vegetation in the vicinity. Pre-settlement vegetation mapping, as derived from historic Federal Land Survey maps prepared in the mid-1800s, will indicate whether riparian vegetation was generally woody or herbaceous, or whether a defined channel even existed prior to settlement.

As discussed previously under "Streamside Landscape Buffers," many northeastern Illinois stream corridors historically were vegetated with prairie and wetland plants, not woody species. Restoration of these areas with principally native herbaceous species would greatly facilitate future stream maintenance needs by reducing the woody vegetation responsible for contributing and trapping debris.

Maintenance of native vegetation on channel banks can use the same techniques previously described for streamside buffers. Annual mowing or prescribed burning are preferred techniques for herbaceous vegetation.

Preserve instream habitat features: A balance should be struck between conveyance needs and stream habitat needs. While a smooth channel free of debris and vegetation may maximize flow conveyance, this condition is highly undesirable for the flora and fauna that naturally reside in stream channels. Also, overly-efficient conveyance can lead to increased flooding and channel erosion downstream.

In developing the maintenance plan, important channel habitat features should be identified for preservation. Logs, twigs, and rocks are essential as cover, spawning areas, and food sources for fish and other aquatic organisms. Consideration should be given, for example, to retaining logs in the channel by anchoring their upstream ends to the channel bank. Such techniques can preserve habitat while minimizing the potential to obstruct flow or floating debris.

The Beaver Issue

Beavers are considered a nuisance by some, and a blessing by others. Beavers can become a nuisance in developed areas due to their persistence in constructing dams on narrow stream channels. These dams can elevate flood heights in localized areas. Beavers also can inflict severe damage on cherished trees in man-made landscapes.

Conversely, beavers are valued for their ability to restore natural functions to riparian areas, particularly those stream corridors that were formerly vegetated with herbaceous wetland and prairie plants and that are now overgrown with non-native woody species. Beavers also are valued for creating pools that provide critical fish habitat in headwater streams during low flow periods.

If management of beavers is necessary, several techniques should be considered. Live trapping is one option, although it is sometimes difficult to find a place to release the trapped beavers. Another option is to insert a pipe or small culvert into the beaver dam, thereby lowering water levels. Without sufficient water levels, the beaver may move to another location. Still another option is to physically remove the beaver dam. While removal is a common first step in many locales, it often will be unsuccessful because beavers are very persistent in replacing dams. When considering any of these techniques, advice should be sought from experts in managing nuisance beavers.

Assistance in Performing Stream Maintenance

While many of the elements of the recommended stream maintenance strategy can be implemented by private landowners without outside assistance, some activities may require special expertise or equipment. This is particularly true in stream channels where maintenance needs historically have been ignored. There are a number of entities that can provide assistance. It should be noted, however, that most agencies stress that routine maintenance is the principal responsibility of the property owner.

Counties/townships/municipalities: Only a minority of local governments actively maintain stream channels. Most, however, perform some maintenance in response to complaints or nuisance situations. As a first step, landowners should contact their local unit of government in securing assistance for major maintenance tasks. Landowners also should contact their local government or highway department to report significant debris accumulations at local road culverts.

Drainage districts: Historically, drainage districts have been granted the statutory authority to maintain stream conveyance in Illinois. However, relatively few streams in the region are currently served by active drainage districts. While previous practices of drainage districts commonly ignored stream habitat concerns, modern drainage districts are beginning to implement more progressive and less-damaging methods. Where active drainage districts exist, landowners should work with them to ensure that environmentally-sensitive maintenance approaches are used.

Countywide stormwater management agencies: Each of the counties in northeastern Illinois has formed a stormwater management planning committee. To varying degrees, these countywide initiatives have recognized the importance of effective stream maintenance programs. DuPage County has implemented a comprehensive maintenance program in cooperation with some local governments, and also has developed a *Stream Maintenance Program Report* that recommends appropriate maintenance approaches. Kane and Lake counties are in the early stages of initiating stream maintenance programs. Landowners should contact countywide stormwater agencies for advice and assistance, where available.

Environmental/citizen groups: There are a number of citizen groups that have adopted local streams for protection and restoration. One of the more popular efforts of these groups is an annual stream cleanup. Volunteer groups such as the Friends of Chicago River and the DuPage River Coalition have removed hundreds of tons of debris in recent years. Landowners should support these groups and coordinate with them in removing and hauling away debris.

Local Examples

The DuPage County Department of Environmental Concerns and **The Conservation Foundation** have initiated complementary stream cleaning programs in DuPage County. The Department of Environmental Concerns has established a countywide *Adopt-A-Stream Program*. This program is directed to citizens and volunteer groups. The Department encourages debris removal twice a year. The Department provides technical support, trash bags, debris collection, and stream safety education. *Adopt-A-Stream* signs also are provided, identifying the name of the volunteer group. The Conservation Foundation, a private, not-for-profit conservation organization, sponsors an annual DuPage County River Sweep in partnership with numerous private corporations and local government agencies. The DuPage River Coalition, a volunteer project of the Foundation, coordinates numerous volunteers and organizations in this event which was initiated in 1991. In addition, both the Department of Environmental Concerns and the Conservation Foundation promote related stream protection initiatives such as natural stream buffer landscaping and volunteer water quality monitoring. The Foundation recently developed "The Stream Wheel" to provide handy information to citizens on topics ranging from streambank erosion to environmentally-sensitive lawn care.

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421 N. County Farm Road
Wheaton, Illinois 60187
630/682-7130

The Conservation Foundation
10 South 404 Knoch Knolls Road
Naperville, Illinois 60565
630/428-4500

Suggested References

DuPage County Stream Maintenance Program Report, R. Stowe and DuPage County Environmental Concerns Department, July 1991.

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3.3 Streambank Stabilization

Rationale for Alternative Bank Stabilization Techniques

While channel erosion is a natural phenomenon, the degree of erosion in many of the region's streams far exceeds natural rates, resulting in losses of property, habitat destruction, water quality impairment, and threats to infrastructure. The conventional solution to bank erosion has been to armor channels with a hard edge, such as concrete, steel, or rock. While such approaches may be locally effective, they typically are quite expensive and destructive of aquatic habitat and may actually lead to increased erosion downstream. In devising alternative, less-damaging solutions, it is important to understand and address the causes that contribute to erosion.

Lack of stabilizing vegetation: Most of the stream channels in the region are vegetated with non-native species, both herbaceous and woody, that invaded riparian areas as a result of previous disturbances such as channelization. Typical herbaceous species, such as Reed Canary Grass and turf grass, are shallow-rooted and are unable to hold streambank soils in place like the native, deep-rooted prairie and wetland species that were found along many streams prior to settlement. Common Buckthorn is a woody species that has invaded many streambank zones. While its roots help to stabilize streambank soils, Buckthorn and other nuisance woody vegetation tend to shade out desirable understory plants. Consequently, barren streambanks are fully exposed to the erosive effects of rain and streamflows, particularly during the dormant season when canopy leaves are gone.

Steep bank slopes: As a result of previous channel modifications and channel erosion, streambank slopes often are relatively steep (i.e., typically steeper than 3:1 horizontal to vertical). Steep side slopes are prone to collapsing, or "sloughing," that occurs when high waters recede and the forces of gravity cause heavy, saturated bank soils to slide downward.

Flow velocities: Peak flow velocities in stream channels are increased by watershed modifications such as impervious surfaces and drained wetlands. Higher velocities translate to higher erosive forces on channel bottoms and banks.

Channelization: Channelized streams are more susceptible to erosion because of the higher energy that results from shortening flow lengths and increasing the channel gradient. The natural tendency of a channelized stream is to meander by cutting into its straightened banks.

The ultimate solution to channel erosion would involve restoring the integrity of the channel as well as stabilizing the hydrology of the upstream watershed. In most watersheds, restoration of pre-development hydrologic conditions is not feasible, although measures such as retrofitting upstream detention basins should be considered. Therefore, attention must be focused on the channel itself. The approach recommended in this handbook deviates from the mostly-structural techniques of the past and instead encourages greater reliance on deep-rooted native vegetation and other "natural" materials and methods. The rationale for this recommended approach is that it preserves or enhances aquatic habitat, dissipates flow velocities, enhances water quality, and is generally less expensive that conventional armoring solutions.

One weakness of the alternative approach is that, unlike structural solutions that provide immediate stabilization, alternative natural techniques do not become fully effective until plant root systems are established. Alternatively, while structural solutions are strongest when first established and may weaken over time, vegetation-based approaches grow stronger with the passage of time.

A Sustainable Streambank Stabilization Strategy

In recent years, several types of alternative natural bank stabilization techniques have been successfully installed in streams and rivers in Illinois. These techniques are commonly labeled "bio-engineering" methods in that they incorporate living plant material with structural practices, resulting in a living erosion control system. While these approaches may be seen as new in this region, bio-engineering approaches have been used for decades in Europe and other parts of this country.

By using native plant species, bank stabilization becomes self-sustaining and, to an extent, self-repairing since the plants are adapted to grow and reproduce in stream channel environments. The use of native vegetation also restores some of the look and feel of the original channel, including enhanced habitat for both terrestrial and aquatic animals.

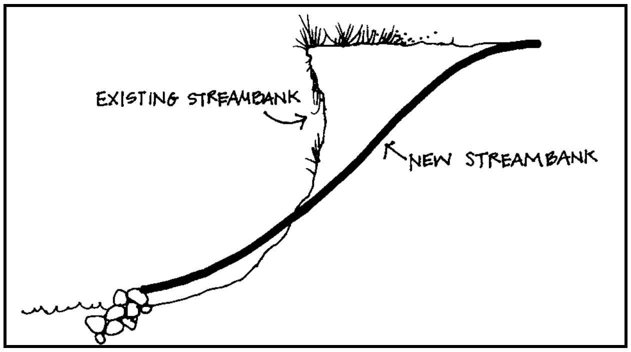
There are several basic elements of most bio-engineering applications.

Toe stabilization: It is critical to stabilize the toe of the streambank where erosion often originates. The toe is where the bank meets the normal water surface. Toe stabilization is particularly important where flow velocities are high, soils are highly erodible, and/or channel banks are steep. Toe stabilization often involves the use of a structural element to both deflect erosive velocities and anchor the upper part of the bank. Vegetation alone can provide effective toe stabilization in some circumstances.

Slope stabilization: By using native vegetation that features extensive, deep root systems, the soil in the banks is bound together by the roots. Plant species selected for bio-engineering applications also are tolerant of wet soils and inundation. Those with the highest tolerance are planted on lower slopes near the water, and those that are less tolerant are planted on upper banks.

Energy dissipation: Vegetation used in bio-engineering applications dissipates some of the erosive energy of streamflows, particularly at the soil surface. Where woody vegetation or shrubs are used, the "roughness" of the channel is increased, thereby lowering velocities in the channel and immediately downstream. A related benefit is the creation of quiet water areas along the bank that allow sediment to accumulate, rather than erode. Before deciding on a bank stabilization approach, landowners should coordinate with local government officials to ensure that local stabilization activities will not worsen upstream flooding problems. Where channel conveyance is a critical concern, there may be a preference for using herbaceous species such as grasses and sedges that will not significantly increase channel roughness.

Bank regrading: On some project sites where banks are very steep and unstable, some regrading may be desirable to create a stable angle of repose. While grading can substantially increase the cost of a project, it may sometimes be necessary in order to ensure long-term stability.



Bank regrading. From *A Citizen's Streambank Restoration Handbook*.

Bed stabilization: In northeastern Illinois streams, typically, the most significant erosion occurs in the horizontal direction, causing the stream channel to widen. To varying degrees, down-cutting also occurs as the channel erodes downward into unstable bottom substrates. Where channel down-cutting is a problem, it will be necessary to stabilize the bed of the stream. This can be done with structures like constructed rock riffles or steel or concrete drop structures. Fortunately, most stream beds in this region are relatively stable due to the presence of underlying substrates of hard clay, coarse gravel, or cobble.

Selection, Design, and Installation of Stabilization Techniques

In developing a stabilization strategy, it is important to understand that a range of conditions is likely to exist within a given reach of stream channel. Some areas may exhibit little or no erosion, and others—such as the outer bends of meandered channels—may be severely eroded. Therefore, stabilization would be needed only where necessary to address stretches of moderate to severe erosion. The remainder of the bank may only require preventative maintenance, such as replacement of unstable turf with deep-rooted native plants.

The selection of a specific technique for a particular streambank location will depend on a number of suitability and cost factors, including the following:

- the severity of existing erosion,
- the steepness of the streambank,
- the degree and duration of water level fluctuation,
- expected flow velocities,
- soil/substrate conditions,
- pre-settlement vegetation conditions,
- the orientation and exposure of the bank to the sun,
- adjacent land uses and related aesthetic considerations,
- long-term maintenance needs, and
- installation and maintenance costs.

There is a relatively extensive array of potential bio-engineering techniques for streambank stabilization. For example, DuPage County has identified the following in its *Streambank Stabilization Program* report:

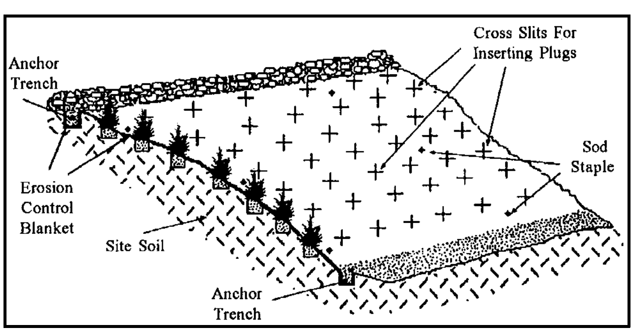
- vegetative stabilization,
- brush mattress,
- live fascines,
- live stakes (or dormant cuttings),
- branch packing (or brush layering),
- live cribwall,
- vegetated geogrid,
- fiber rolls,
- A-Jacks, and
- lunker structures.

These techniques are described and their advantages and disadvantages are discussed in the *Streambank Stabilization Program* report. Where erosion problems are moderate to severe, landowners should consult with experts before deciding on a remedial plan. A list of resource and regulatory agencies is provided at the end of the handbook. Landowners also should be aware that a permit generally is required for many streambank stabilization projects, particularly those involving structural methods or any regrading of the channel. Both resource agencies and qualified consultants can provide guidance on the permit process.

It is important that landowners are aware that bio-engineering techniques often can provide the same level of erosion protection as more expensive conventional structural approaches, and do it in a more environmentally-sensitive manner. While the listed bio-engineering techniques, and others, may be considered for any particular stabilization project, this handbook will present a sampling of just four techniques. These techniques were selected because they can address a range of erosion problems, are relatively straightforward to understand and install, and have produced successful results on a number of demonstration project sites in the region in recent years.

The presentation of these four techniques is not intended to imply that others are any less appropriate. Further, choosing among the various techniques is not an either-or proposition; sometimes a combination of two or more methods is more appropriate than any single method.

Vegetative Stabilization: Vegetative stabilization involves planting appropriate native vegetation, such as that listed at the end of this section, on streambanks and in shallow-water zones. Effectiveness is dependent on the presence of suitable soils. Vegetative stabilization is most appropriate where erosion problems are not already severe, and on relatively flat slopes (typically 2:1–3:1 horizontal to vertical, or flatter). Vegetative measures also work well in combination with structural bio-engineering techniques for more serious problems, and as a preventative technique to replace conventional turf grass landscaping before significant erosion begins.



Vegetative stabilization. Source NIPC and Dynamac Corporation.

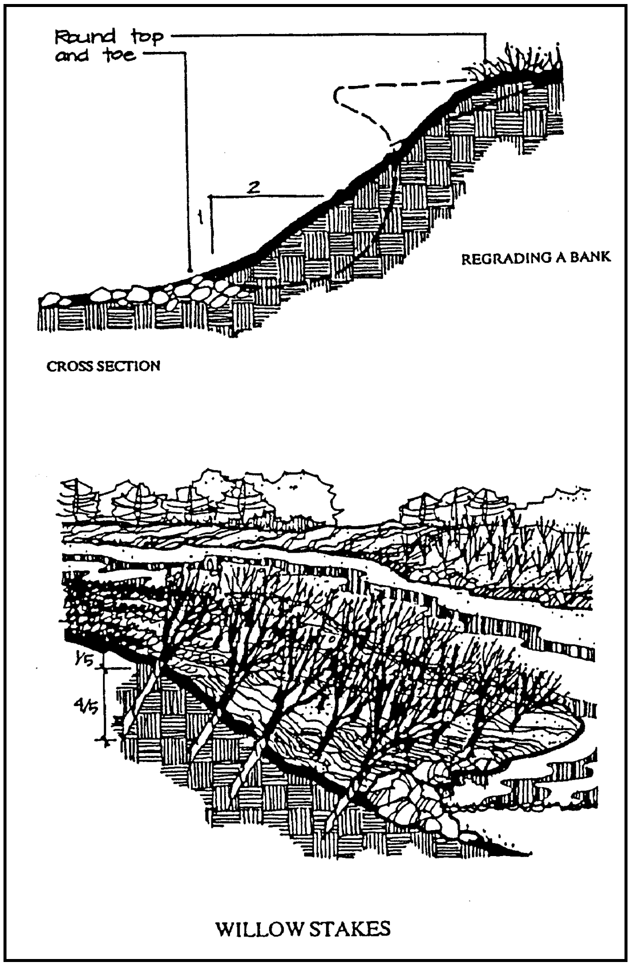
Vegetative stabilization typically begins with the removal of existing non-native, undesirable vegetation as described previously in this handbook. This is particularly important if undesirable woody vegetation is shading out understory plants. If native herbaceous vegetation is used for stabilization, it generally is desirable to reduce the shade canopy to 50 percent or less. Next, minor bank regrading may be necessary to create a stable slope.

Advice on plant selection should be sought from an expert. Plants can be introduced as plugs or seeds. Plugs are strongly preferred on lower banks because they provide more rapid stabilization and are less prone to washing away if water stages rise. Planting preferably should be done in late spring to early summer when soil moisture levels are favorable. Early planting also allows sufficient time for effective root establishment during the first growing season. If unusually dry conditions persist after planting, irrigation should be provided. Temporary soil stabilization measures, such as an erosion control blanket and/or cover crop, are needed until the new vegetation becomes fully established. Temporary stabilization is particularly important if seed is used.

On stream reaches where velocities are low, planting of emergent wetland vegetation is encouraged in shallow water zones to enhance the stability of the toe of the slope. The appropriate zone for emergent wetland vegetation typically is from normal water elevation to a depth of one-half to one foot.

The principal advantage of vegetative stabilization is that installation is simple and often can be implemented by volunteers or homeowners. The approximate cost of vegetative stabilization is $10 to $20 per linear foot. This cost can vary depending on the plant species selected and whether outside (i.e., hired) labor is used.

Dormant Cuttings: In a natural streambank setting, the areas exhibiting the greatest stability are often colonized by native woody riparian shrubs, such as Sandbar Willow (*Salix interior*) or Red-Osier Dogwood (*Cornus sericea*). These plants have extensive fibrous root systems that grow towards the water, stabilizing the soil through which



Stream stabilization with minor regrading and dormant cuttings. Source: NIPC and Dynamac Corporation.

the roots penetrate. These and other riparian species can often propagate themselves when live branches break off, float downstream, and root where they run aground on a suitable substrate. The tendency for these shrubs to quickly establish themselves on streambanks can be used to provide rapid erosion control.

The use of such vegetation is a proven, highly-effective means of solving streambank erosion problems. The dormant cutting technique also is relatively inexpensive, costing roughly $10 to $20 per lineal foot. By using native shrubs and trees that feature extensive root systems, the soil in the banks is bound together by the roots. The top growth serves to deflect erosive stream flows away from the bank, creating quiet water areas along the bank that can even allow sediment to accumulate, rather than erode. The friction caused by the vegetation also serves to dissipate the energy of the stream, reducing the potential for erosion problems to be transferred to locations downstream.

Before dormant cuttings are installed, it may be necessary to reduce the shade canopy to 50 percent or less. Some bank regrading also may be necessary to create a stable slope.

Cuttings must be harvested in a dormant state, typically during October to March, and preferably should be planted within two weeks. The cuttings should be two to four feet in length, and ½ inch to 1-1/2 inches in diameter. Pilot holes should be made by driving a metal bar into the bank perpendicular to the slope on four- to five-foot centers. Cuttings should then be packed firmly into the holes. To enhance their survival, the ends of the cuttings must extend into moist soil. Also, to ensure stabilization of the toe of the slope, the ends of the lower rows of cuttings should extend below the elevation of the streambed.

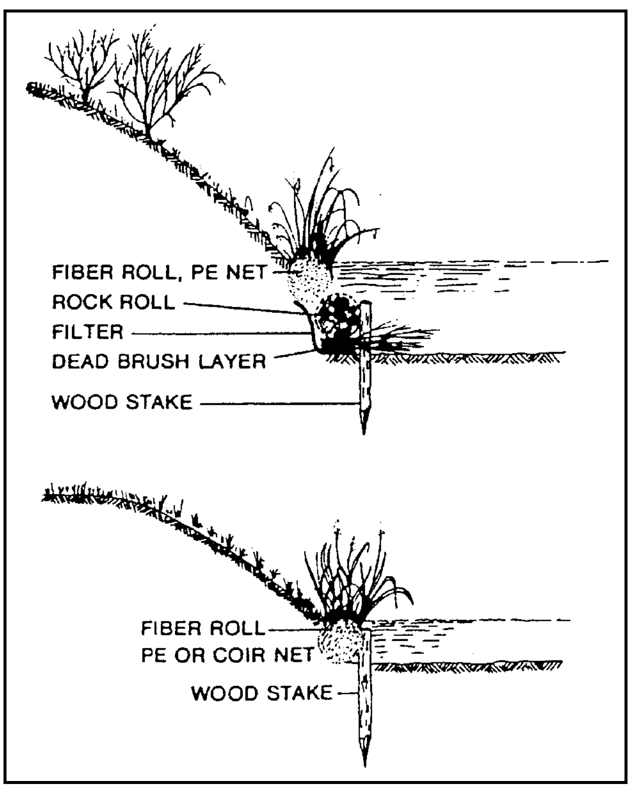
Appropriate temporary erosion control measures should be installed to provide soil stability while the cuttings are becoming fully established. In areas where stream velocities and erosive potential are more extreme, a combination of dormant cuttings and structural solutions may be necessary.

Fiber Rolls: Fiber rolls are sausage-like cylinders of compacted coconut husk fiber, wrapped with a coconut fiber mesh. Roughly the diameter of a basketball, the rolls are installed in shallow water at the base of a streambank to provide immediate toe protection. Fiber rolls are used in combination with native vegetation and can provide effective stabilization in moderate erosion zones. Fiber rolls can provide an added advantage of trapping eroding streambank soils, thus keeping larger sediment particles out of the stream and providing a good medium for plant establishment. With these characteristics, fiber rolls are able to remediate more severe erosion problems than vegetation alone. The cost of fiber roll installations ranges from approximately $25 to $35 per lineal foot.

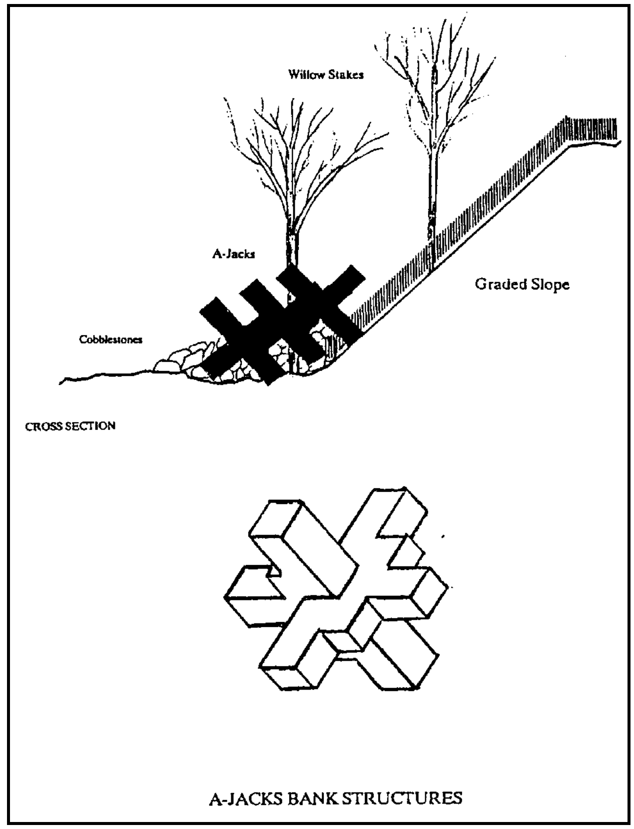
Fiber rolls should be either entrenched directly against the bank or placed in shallow water adjacent to the bank. In either case, they should be approximately two-thirds submerged under normal flow conditions. The rolls must then be staked securely in place. The rolls should be planted with appropriate species of water-tolerant shrubs, grasses, and sedges. Recent experience indicates that plant survival in fiber rolls will be improved by inserting the plants deep enough to reach water and by waiting a sufficient period of time (e.g., several weeks) for the rolls to begin to accumulate sediment. Streambanks above the rolls should be planted with native herbaceous plants or dormant stakes.

Once saturated with water, the rolls become very heavy and difficult to move. Being biodegradable, the rolls will eventually break down in five to seven years. In the intervening time, however, the introduced native plant material behind the fiber roll becomes so well established that it provides the long-term streambank stabilization.

A-Jacks Structures: An A-Jacks structure is comprised of two identical pieces of pre-cast concrete that when fitted together form a small six-legged cube approximately two feet square in size and weighing approximately 70 pounds. A-Jacks are set into the base of the streambank to provide effective toe protection for moderate- to high-velocity areas. While somewhat more expensive than the preceding techniques at $30 to $75 per lineal foot, A-Jacks installations are still substantially less expensive than conventional structural techniques that often cost upwards of $100 per lineal foot.



Fiber rolls at the toe of a streambank. Source: Bestman Green Systems Inc.



A-Jacks and willow stakes used for streambank stabilization. Source: NIPC and Dynamac Corporation.

As the assembled A-Jacks structures are identical in shape, they can be nested together in a linear fashion into a shallow trench excavated along an eroding streambank. Once installed, the remaining void spaces within the A-Jacks structures are filled with an erosion control product and covered with soil. The backfilled area is then planted with native species of water-tolerant trees, shrubs, and grasses. The roots of these plants eventually wrap around the buried A-Jacks structures and penetrate the underlying parent soil material. By being flexible, the A-Jacks structures can shift without cracking or failing. The vegetation provides an additional measure of protection, creating a living system of erosion control.

Maintenance Needs

Newly-installed stabilization measures should be closely monitored to ensure that failures do not occur. Adequate soil moisture should be provided for new plantings, as necessary. If a significant portion of the new plantings do not survive, they should be replaced when conditions are favorable. Selective use of an approved herbicide also may be helpful in controlling invasive weed species until native vegetation is fully established.

Guidance for long-term maintenance is similar to that recommended previously under "Stream Channel Maintenance." Maintenance typically will involve annual or biennial controlled burns (or mowing) to control non-native plants and prevent invasion by undesirable woody plants.

Local Examples

The Chicago Botanic Garden in Glencoe applied bio-engineering stabilization techniques to a nearly mile-long, low-gradient stretch of the Skokie River. The river channel on the Botanic Garden's property was experiencing severe erosion in some areas due to a combination of altered upstream hydrology and a complete lack of stabilizing, deep-rooted vegetation. It was determined that erosion was due principally to sloughing of saturated bank slopes following flood events. To address this type of erosion problem, the recommended solution was an assortment of bio-engineering techniques that relied almost exclusively on native vegetation. For the least eroded banks, plugs of Prairie Cordgrass were planted. On banks where erosion was moderate to severe, dormant willows were used. The willows were planted using both the dormant cuttings approach described above and a brush layering technique, where numerous small cuttings are lain in horizontal layers and subsequently covered with earth. This project also used coconut fiber rolls in several locations where velocities were relatively high and stabilization of the toe was critical. This project, developed as a demonstration, presents a good opportunity to view a variety of streambank stabilization techniques and examine their effectiveness. Some of the techniques are working quite well while others are of limited success. This site is easily viewed from trails and roadways along the west side of the Garden property.

Contact: Joan O'Shaughnessy
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847/835-8312

The Flint Creek Restoration Project involved the stabilization of eroded streambanks in several communities in southwestern Lake County. Projects were implemented by four entities: the Villages of Barrington and Lake Zurich, the Lake County Forest Preserve District, and Citizens for Conservation (a local land conservation group). The gradient of Flint Creek, at about eight feet per mile, is typical of small streams in northeastern Illinois but is considerably steeper than the Skokie River. Considering this gradient and the velocities associated with it, a more conservative approach was taken in contrast to the almost exclusive reliance on vegetation in the Skokie River project. The restoration objectives were to stabilize eroding channel banks and to remove excessive debris and non-native trees and shrubs that were shading out understory vegetation and causing flow obstructions. After clearing undesirable woody vegetation, a combination of soil bio-engineering techniques was installed to stabilize the streambanks. Treatments ranged from vegetative stabilization in the least severe erosion zones, to the installation of A-Jacks, coconut fiber rolls, and lunker structures, in combination with native vegetation and erosion blanket, on more severely eroded banks. Installation was implemented by outside contractors, municipal staff, Forest Preserve District staff, and volunteers, depending on the project site. Installations were completed in 1996 and proved to be very successful. All of the stabilized sites successfully withstood severe flooding conditions in February of 1997.

Contact: Tom Price, Project Coordinator
Northeastern Illinois Planning Commission
222 S. Riverside Plaza, Suite 1800
Chicago, Illinois 60606
312/454-0400

Suggested References

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Field Manual of Urban Stream Restoration, R. Newbury, M. Gaboury, C. Watson, and the Nonpoint Pollution Control Program of the Illinois State Water Survey, Illinois Department of Natural Resources: D. Roseboom, T. Hill, J. Beardsley, J. Rodsater, and L. Duong, Published by Conservation Technology Information Center for the U.S. Environmental Protection Agency and the Illinois Environmental Protection Agency, 1998.

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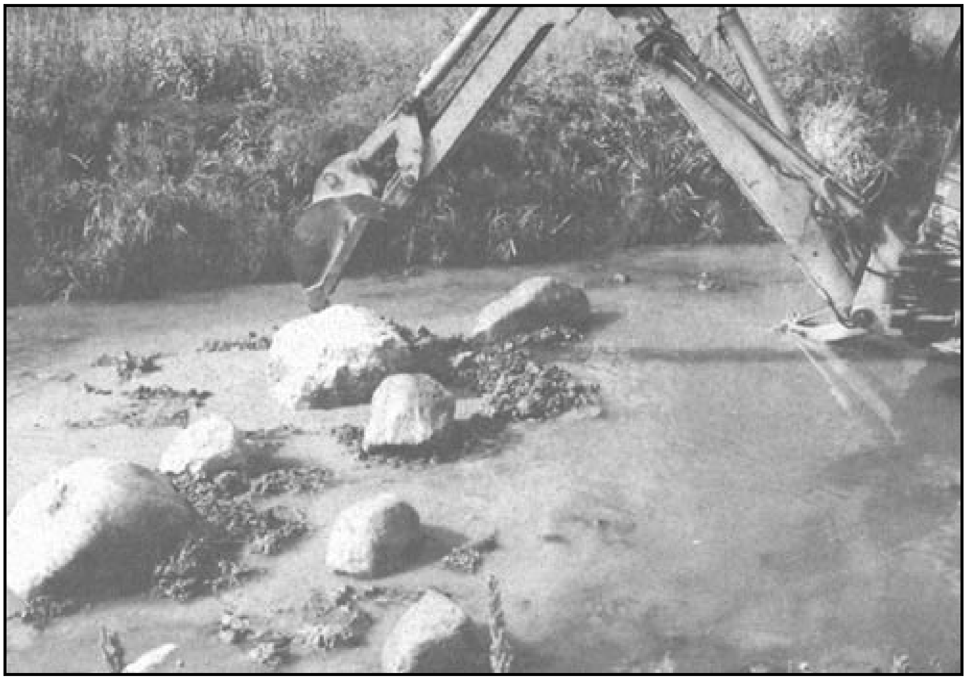
3.4 Instream Habitat Restoration



Looking for Restoration Opportunities

Instream habitat includes features of natural stream channels   pools, riffles, meanders, aquatic vegetation, and bottom substrate   that are important to healthy and diverse communities of aquatic organisms. In most streams, there will be significant opportunities for restoration of aquatic habitat. In some cases, habitat restoration measures can be designed into stabilization and maintenance projects, as described previously. They also can be done by landowners independent of other activities.

Often, new development or redevelopment activities present opportunities for restoration of degraded stream channels on the development site. A highly-degraded natural system is not only low in functional value but is also unaesthetic. Hence, a developer may see an opportunity to enhance the aesthetics of the property while also benefitting water quality and habitat functions. In this situation, the cost of restoration may be offset by enhanced property values.

Habitat restoration projects can range from simple measures that can be readily implemented by landowners, to extensive reconfiguration of a stream channel that requires considerable design expertise and financial resources. In general, though, landowners always should seek the advice of recognized experts before embarking on channel restoration. An improperly designed restoration could cause more harm than good, despite sound intentions.

Several types of restoration are discussed in this section. These include:

- planting native vegetation in the channel,
- enhancing riffles,
- enhancing or recreating channel meandering,
- and modifying or eliminating channel dams.

Planting Native Vegetation in the Channel

Due to a number of factors, including unstable flows, sedimentation, and/or water pollution, stream channels may lose desirable native vegetation. However, if these factors can be controlled—i.e., the stream's hydrology and water quality are stabilized—there may be opportunities to restore native plant communities on lower channel banks, on point bars, and in quiet, shallow-water zones.

To date, there has been relatively little experience in northeastern Illinois with this approach. A technique that has been utilized on several project sites has been the planting of live plants or root stock of emergent wetland species. An Illinois Department of Natural Resources report, *An Evaluation of Selected Emergent Plant Species: Potential for Habitat Enhancement and Stream Bank Stabilization*, provides useful guidance on plant species that may be suitable in these zones.

Enhancing Riffles

Alternating sequences of pools and riffles are basic elements of natural stream channels. The pool/riffle sequence generally conforms to a channel's meander pattern. Generally, pools occur at the outside bends of meanders, followed by riffles at the head of a relatively straight section of channel.

In degraded channels, particularly where channelization has occurred, the pool/riffle sequence is typically diminished or even eliminated. There may be an opportunity to enhance such conditions, however, by placing large stone or cobbles on top of existing riffles. Such riffle enhancement can improve habitat for fish and other organisms, enhance aeration of the water, and improve aesthetic conditions. However, restraint should be exercised to avoid the creation of small dams that could impede the movement of fish.

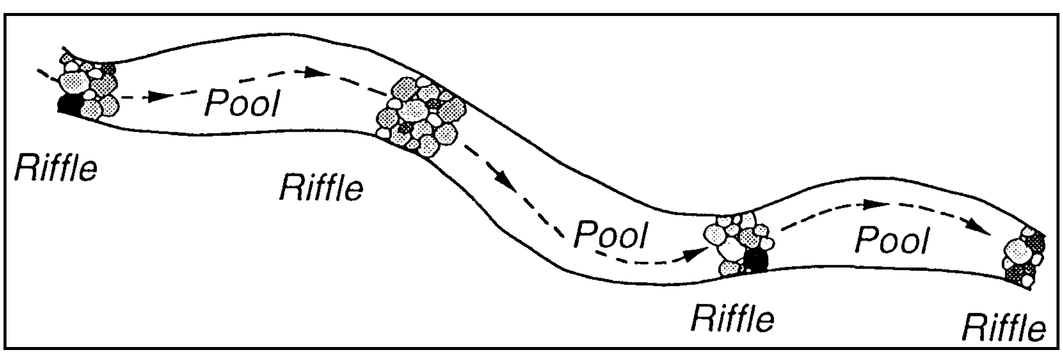
Another technique for enhancing riffles is to construct artificial deflectors. Deflectors are placed in an alternating pattern to direct the flow back and forth across the channel. Deflectors can enhance low flow velocities and their scouring effect can flush undesirable sediment from gravel and cobble substrates.

Enhancing or Recreating Channel Meandering

Because so many streams in northeastern Illinois have been artificially straightened, there are numerous opportunities for enhancing or recreating meanders. However, recreating meanders in channelized streams is a more formidable undertaking than some other habitat restoration measures because it typically will involve substantial excavation and regrading. In addition to being relatively expensive, great care must be taken in the design and construction of a re-meandered channel to ensure that it is stable and does not become an erosion problem. Nonetheless, recreating channel meanders can provide important habitat benefits and enhance the aesthetics of a channelized, artificial-looking stream.

There are well-defined scientific principles that provide the basis for designing channel meanders. Numerous studies around the country have established a relationship between meander frequency and stream width. Meander location also is directly related to the sequencing of pools and riffles. Unfortunately, there has been very little experience in this region in recreating meanders in channelized streams.

A potential alternative to relocating the stream channel to create meanders is the enhancement of meander patterns within the banks of an existing channel.



Typical pool/rifle sequence. From *Field Manual of Urban Stream Restoration*.

Channelized versus meandering stream. From *A Citizen's Streambank Restoration Handbook*.

This may be appropriate in channels that have widened over time due to bank erosion. In fact, the widening of channelized streams is actually a natural process in which the stream is attempting to dissipate energy by gradually recreating meanders. Enhancement of meanders can be accomplished via the introduction of flow deflectors that help to accentuate a low-flow channel within the broader channel. Deflectors can be constructed with rocks or cobbles or, as described in one of the "local examples" below, with coconut fiber rolls.

Modifying or Eliminating Channel Dams

Most of the larger streams and nearly all of the rivers in the region have one or more low-head dams across their channels. In many cases, the original purpose of the dam—e.g., a ford for farm wagons or diversion of flow for a grist mill—is no longer valid. There are a number of reasons to consider for eliminating these dams. Probably the most important reason from the perspective of aquatic biodiversity is the constraint that channel dams impose on fish migration. In general, the warm-water fish species that populate area streams are unable to move upstream over typical dams that range in height from about three to ten feet. As a consequence, fish diversity may be substantially lower upstream of channel dams, particularly in the small to moderate sized streams.

There are several basic approaches to consider to eliminate dam impediments to fisheries. The first is to construct a fish ladder to provide a less-steep flow path for fish to swim around or over the dam. Based on experience around the country, fish ladders are only partially successful in reducing fish migration impediments.

A preferred approach is to eliminate the difference in stage above and below the dam by removing or slotting the dam. This approach allows free movement of fish and other aquatic organisms. It also eliminates the dam as an impediment to recreational watercraft and it eliminates the adverse effects that impoundments have on water quality.

As with other habitat enhancement measures discussed in this section, dam modification should only be considered with the advice of a multi-disciplinary team that includes engineering, morphology, and aquatic biology expertise. Landowners also should coordinate any dam modification activities with appropriate regulatory agencies, including the county stormwater planning agency, IDNR/OWR, and the Army Corps of Engineers. In most cases a permit will be required to verify that there are no adverse effects on upstream or downstream flooding.

Obtaining Qualified Technical Assistance

Channel restoration work, particularly if it may potentially affect flow characteristics, requires the design guidance of recognized experts in channel hydraulics, morphology, and aquatic ecology. In particular, landowners should utilize recognized professionals on any projects involving riffle enhancement, channel meanders, or dams.

Advice, and potentially funding, may be available from resource agencies such as the U.S. Fish and Wildlife Service and the Illinois Department of Natural Resources. There also are a number of private consultants qualified in restoration activities. Before hiring a private consultant, it is recommended that landowners verify that the consultant has successfully completed similar restorations on other sites.

It should be recognized that most channel restoration projects will require permits from the Illinois Department of Natural Resources, Office of

Water Resources, the U.S. Army Corps of Engineers, and the Illinois Environmental Protection Agency. In some cases, permits from local governments also may be required.

Local Example

The Lake Forest Open Lands Association, a private not-for-profit organization, with support from the Friends of the Chicago River, the Youth Conservation Corps, and the Illinois Environmental Protection Agency, rebuilt 200 feet of river edge on Open Lands' Mellody Farm Nature Preserve along the Middle Fork of the North Branch of the Chicago River.

Riverbanks that were nearly vertical or at 1:1 slopes were reworked to a minimum of 10:1 grades and the toe of the bank was anchored with a coconut fiber roll manufactured on-site by the Youth Conservation Corps. Topsoil was placed on the regraded banks and the base for a new trail with river overlooks was constructed. This trail base will be covered with wood chips when the rest of the preserve is developed for public use so visitors can experience first-hand the entire restoration process and have access to the river. Open Lands' staff and the Youth Conservation Corps planted the new banks with approximately 7,000 wet-mesic prairie and sedge meadow plants and spread over 100 pounds of native grass and forb seed. The coconut fiber roll at the toe of the bank was "sprigged" with willow seedlings collected on site. In all approximately 90 plant species were used. The entire project was then covered with erosion control blanket and received regular watering for the rest of the summer.

The project, completed in summer 1997, is a good example of stream-edge restoration and will serve as an experimental model for the Lake County Forest Preserve District as it considers restoration of several miles of channel bank along the adjacent Middle Fork Savanna.

Contact: Stephen Christy
Lake Forest Open Lands Assoc.
272 Market Square, Suite 2726
Lake Forest, Illinois, 60045
847/234-3880, ext. 13

Suggested References

A Citizen's Streambank Restoration Handbook, K. Firehock and J. Doherty, Isaac Walton League of America, January 1995.

An Evaluation of Selected Emergent Plant Species: Potential for Habitat Enhancement and Stream Bank Stabilization, S. Pescitelli and R. Rung, Illinois Department of Natural Resources, Division of Fisheries, 1997.

Field Manual of Urban Stream Restoration, R. Newbury, M. Gaboury, C. Watson, and the Nonpoint Pollution Control Program of the Illinois State Water Survey, Illinois Department of Natural Resources: D. Roseboom, T. Hill, J. Beardsley, J. Rodsater, and L. Duong, Published by Conservation Technology Information Center for the U.S. Environmental Protection Agency and the Illinois Environmental Protection Agency, 1998.

Stream Analysis and Fish Habitat Design: A Field Manual, R. Newbury and M. Gaboury, Newbury Hydraulics Ltd., Gibsons, British Columbia, 1993.

3.5 Accommodating Trail Access

Trails in Stream Greenways

Including trails in stream corridors can greatly enhance the benefits of publicly-owned riparian land. While there are obvious recreational benefits that contribute to the quality of life for adjacent property owners and communities, studies have also shown increases in property values and property tax revenues, increased spending for outdoor recreation, and improved tourism markets. In areas where it is desirable to acquire publicly a stream corridor for reasons such as flood control and habitat protection, proposing a trail may be a way to gain local support for the project.

Streamside trails can increase awareness of the natural resource values of streams. This environmental awareness can provide the impetus for stewardship activities among trail users: people seeing and using the corridor are more likely to feel invested in its health and well-being. In addition, trail use can provide an informal surveillance of the corridor, which can add safety benefits as well as a system for reporting activities such as vandalism or illegal dumping.

While the benefits of trails are numerous, it is important to recognize their potential for negative effects on streams and buffers. Construction of the trail, alignment and design of the trail, use of the trail, and maintenance of the trail can individually or collectively wreak havoc on riparian resources and natural functions. For example, extra wide swaths of vegetation are sometimes wiped out in order to design for unnecessarily high-speed bicycle travel; soil erosion and sedimentation measures are not conservative enough to protect degradation during construction; inappropriate trail design can worsen flooding problems. Ways to prevent and/or mitigate these effects will be addressed in this section.

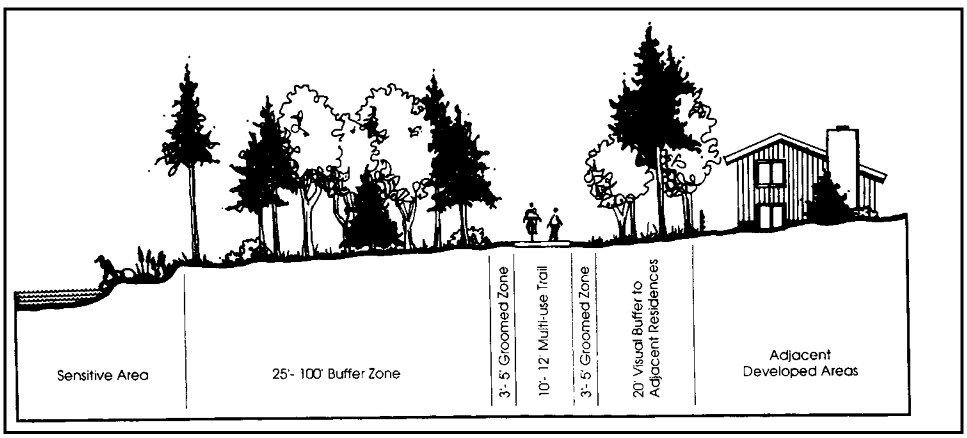
The decision to construct or not construct a trail should be based on an examination of the potential impacts and on communication between the trail interests and environmental interests, especially where those interests diverge. If the decision is made to construct a trail, environmental issues should be addressed early in the planning and design phases, and through the maintenance and long-term management of the facility.

Planning the Trail

In the early stages of planning the trail, issues such as sensitive habitats, flooding, and wetlands should be identified, as well as applicable agency regulations and recommendations. One suggested approach is to conduct a "walk through" at which all relevant agencies and organizations are represented. Small flags can be put down on the spot to represent an agreed-upon, environmentally sensitive alignment. Ideally, this step should take place early enough to inform the budget process, since trail location can greatly impact costs. The budget also should include habitat protection (including controlling invasive species) as a component of the trail corridor maintenance and management program.

The following is a list of factors influencing the potential for resource damage caused by trail construction and use:

- sensitive plants and wildlife,
- wetlands,
- flooding frequency,
- sensitive soils,
- slope/topography,
- sun exposure (e.g., southern vs. northern),
- type of trail (e.g., paved vs. unpaved), level of maintenance needed, and
- type and degree of use (e.g., vehicular vs. pedestrian).



Trail buffer cross section. From *Greenways: A guide to Planning, Design, and Development*.

Trail Location and Other Design Considerations

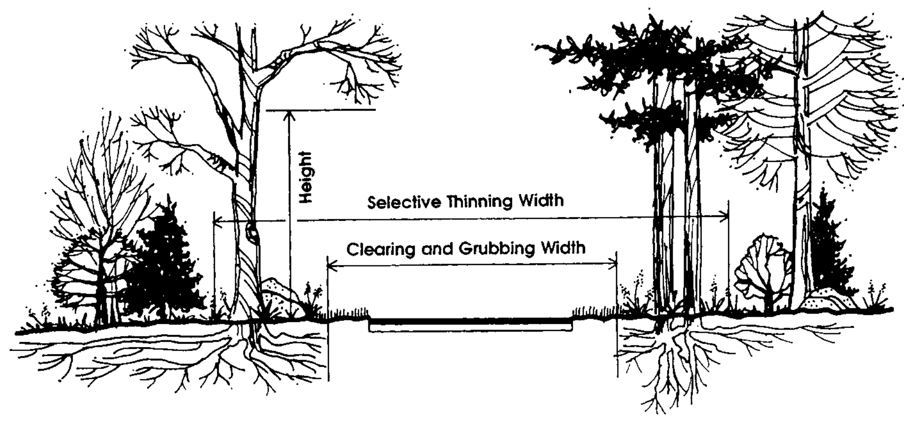
The selection of routing and design options should be guided in part by minimizing or mitigating the impacts to sensitive habitats and other stream related resources. Consider the following possibilities:

- Design to discourage unwanted diversions off the trail surface; use plantings and signs to discourage "cutoffs" from the trail.
- Direct the trail away from areas of critical or sensitive habitats; leave buffer between any critical area and trail edge; consider closing the trail during critical times such as breeding season; provide interpretive material describing wildlife values along corridor.
- Locate facilities such as parking lots away from sensitive areas; better yet, investigate opportunities for sharing existing parking.
- Use existing structures where feasible (e.g., bridges, existing rights of way).

Due to the variety of land, water, bank and habitat considerations, there is no single answer to the question of appropriate setback from the stream. The sample cross-section below, however, suggests a 25-100 foot buffer between the trail and the streambank. For more information on buffer treatment, refer to that section in this handbook and sources cited there.

The same source also recommends keeping horizontal and vertical clearing of vegetation to a minimum. The chart below shows recommended clearing for the various types of trails.

If there is a concern of not meeting bicycle design specifications and standards set forth by a funding agency, consider contacting the agency in advance to verify that there is flexibility to accommodate environmental concerns. It is the policy of some trail funding agencies to relax standards (such as IDOT with AASHTO Guidelines) for bicycle facilities in situations where there is a clearly stated reason to do so.



Trail Type	Clearing & Grubbing Width	Selective Thinning Width	Clearing Height
6-foot hiking only	10 feet	20 feet	8 feet
8-foot pedestrian only	14 feet	24 feet	8 feet
10-foot pedestrian only	16 feet	26 feet	8 feet
8-foot bicycle only	16 feet	26 feet	10 feet
10-foot bicycle/pedestrian	18 feet	28 feet	10 feet
6-foot horse only	12 feet	22 feet	12 feet
10-foot horse/pedestrian	16 feet	26 feet	12 feet
8-foot cross-country ski only	12 feet	22 feet	8 feet
12 foot snowmobile only	20 feet	30 feet	10 feet
18-foot ski/snowmobile	26 feet	36 feet	10 feet

Suggested clearing widths. From *Greenways: A Guide to Planning, Design, and Development*.

There are numerous resources available that address the specifics of trail design, such as appropriate surfacing depending on the type of trail, expected level of use, topography, soils, etc. In general, water-permeable surfaces such as granular stone are preferable to asphalt and concrete in areas of sensitive habitat. Where trails must cross soft, water-saturated soils, there may be problems with muddy trails, soil compaction, and sedimentation. Geosynthetics (e.g., geo-textiles, geo-nets, sheet drains, geo-grids, geo-cells) are suggested for use with soil or rock to provide separation, reinforcement and drainage over wet, unstable soils. Additional design guidance is included in the sources cited at the end of this section.

Managing the Trail

The plan for managing the trail should consider coordination with other agencies, schools, and advocacy organizations to pursue opportunities for education, public awareness and stewardship. Planning for events and activities related to the stream corridor should include outreach to trail users. Trail signage can be used to convey information about habitats and natural resource values, as well as contact numbers for stewardship organizations active in the corridor (such as "Friends of ..." organizations and "Riverwatch" initiatives). Trail users should also be advised regarding ways to tread lightly on the land, including traveling where permitted and avoiding streambanks, muddy areas and sensitive habitats. Contact numbers should also be included for reporting vandalism and illegal dumping.

Suggested References

Greenways: A Guide to Planning, Design, and Development, L. LaB Schwarz, C.A. Flink, and R.M. Stearns, Island Press, 1993.

Geosynthetics for Trails in Wet Areas, S. Monlux, Technical Report 0E02A40 of the U.S.D.A. Forest Service, 1995. (videos also available from Forest Service: "Trails in Wet Areas," 1994; "Basic Trail Maintenance," 1995; "Surface Water Control Technique for Trail Maintenance," 1994. Call (406)329-3900.

Recreation and Wildlife: Two Views on the Great Trails Debate, G. Sprung and D. Hall, Trail Tracks, Vol. 26, No.2, 1997.

Tools of the Trail: a Bibliography on Planning, Advocating, Designing, Building, Maintaining and Managing Trails throughout America, P. Ward, ed., American Hiking Society for the National Park Service, 1994.

Trails: An Amenity for Property Owners and Communities, NIPC and Openlands Project for the Illinois Prairie Trail Authority, 1997.

Trail Design Issues in Environmentally Sensitive Areas, L. Warneke, NCRC Technical Bulletin No.1., National Park Service, 1996.

Trails for the Twenty-First Century: Planning, Design, and Management Manual for Multi-Use Trails, K.L. Ryan, ed., Island Press, 1994.

Tread Lightly! on Public and Private Land: A National Land Use Ethics Program, U.S. Forest Service, 1991.

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Resource Agencies

U.S. Army Corps of Engineers
Chicago District, Regulatory Branch
111 N. Canal
Chicago, IL 60606
312/353-6428

U.S.D.A.–Natural Resources Conservation Service
Chicago Metro Urban
and Community Assistance Office
603 East Diehl Rd.
Naperville, IL 60563
708/505-7808

U.S. Environmental Protection Agency
Region 5 (5WW-16J)
77 West Jackson Blvd
Chicago, IL 60604
312/353-2308

U.S. Fish and Wildlife Service
Chicago Illinois Field Office
1000 Hart Rd., Ste 180
Barrington, IL 60010
847/381-2253

National Parks Service
Center for Conservation,
Recreation, and Resources
310 West Wisconsin Avenue, Suite 100 East
Milwaukee, WI 53203
414/297-3617

Illinois Department of Natural Resources
Division of Fisheries
5931 Fox River Drive
Plano, IL 60545
630/553-0164

Illinois Department of Natural Resources
Division of Planning
524 South 2nd Street
Springfield, IL 62701
217/782-3715

Illinois State Water Survey
Office of Water Quality Management
P.O. Box 697
Peoria, IL 61652
309/671-3196

Chicago Botanic Garden
1000 Lake Cook Road
Glencoe, Illinois 60022
847/835-8312

DuPage County Department
of Environmental Concerns
421 North County Farm Road
Wheaton, IL 60187
630/682-7130

Lake County Stormwater Management Commission
333-B Peterson Road
Libertyville, IL 60048
847/918-5260

The Nature Conservancy
8 South Michigan Avenue, Suite 900
Chicago, IL 60603
312/346-8166

Northeastern Illinois Planning Commission
Natural Resources Department
222 South Riverside Plaza, Suite 1800
Chicago, IL 60606
312/454-0400

Openlands Project
222 South State Street, Room 1800
Chicago, IL 60604
312/427-4256

Kane-DuPage Soil and Water Conservation District
545 Randall Road
St. Charles, IL 60174
630/584-7961

Lake County Soil and Water Conservation District
100 N. Atkinson Road, Suite 102-A
Grayslake, IL 60030
847/223-1056

North Cook County Soil
and Water Conservation District
899 Jay Street
Elgin, IL 60120
847/468-0071

McHenry County Soil
and Water Conservation District
1143 N. Seminary Avenue
Woodstock, IL 60098
815/338-0099

Will-South Cook County Soil
and Water Conservation District
1201 S. Gouger Rd.
New Lenox, IL 60451
815/462-3151