

# TAKEN BY SURPRISE?

## Over-development and Stream Bank Erosion

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“They paved paradise and put up a parking lot!” Songs of the sixties often included some reference to the impact civilization was having upon our home and warned listeners that the urbanization of our wilderness lands wasn't necessarily a good thing. The argument tended to come down to "progress versus the tree-huggers," and not much has changed in the last thirty years. Overdevelopment - urban sprawl - impacts our lives, our future, and our planet, and there are no clear indications that plans are under way to control the sprawl. Worse, it appears that, when stabilizing slopes and streambanks, few designers plan for future sprawl and its impacts, ensuring the future failure of today's projects. Investigation indicates that, when projects fail because future developments were not accounted for in the design stage, developers, planners, agencies, contractors, and ultimately the homeowner all seem to be taken by surprise. Such events and results are foreseeable.

### **Overdevelopment and The Ghosts of Urban Sprawl**

Earth Day 1970 as celebrated on the Ball State University campus in Muncie, Indiana was devoted to Zero Population Growth, a battle cry we don't hear very often since birth control measures started showing up on shelves in mainstream shopping centers. Perhaps the time has come to wage that battle once again. Human population growth and the increased demand for natural resources negatively impacts other species as well as the ecosystems we depend on to sustain human life. Converting natural areas to *urban* areas seems to be "the American way" of dealing with an expanding human population. While everyone claims to be opposed to sprawl, we allow it to gobble up and fragment a huge amount of the environment. And while we may think we are creating human habitat as we spread out, we ultimately make a world inhospitable not only to other species, but to humans as well. (Zero Population Growth Reporter)

What exactly is Urban Sprawl? It is the pattern of low-density expansion of large urban areas into the surrounding areas and implies little planning control of land subdivisions. The development is scattered and strung out. It contains three major forms: low-density continuous development, ribbon development, and leapfrog sprawl. Low-density continuous development takes place as an area extends its arms further outside of its boundaries, adding it to the metropolis. Ribbon development is what occurs on main roads leading in or out of the metropolitan area. This occurs on either side of the road and commonly extends for many miles because of the easy access of the road. Leapfrog sprawl is when development leaps around like a frog and sometimes skips areas and connects to the metro areas by road or route, depending on water locations. (Weber)

Development can obviously be beneficial. Witness the upgrade in wages and the rise in numbers of available jobs in areas where new homes and new businesses are built. Enticing new blood into a community is of great value to the residents, raising the likelihood of the area's continued viability. But what happens to the other species that live in the areas to be developed?

Look closely between the cracks in the sidewalk, at the weeds in your backyard, at the paw prints that meander away from your trash can---there you will find the ghosts of urban sprawl. They are the animals and plants that lived in the forests, ponds, grasslands, and wide-open deserts before the edges of the city crept out and sprinkled the land with patches of pavement. These are the species that have managed to adapt to a new, more urban way of life. Others have found the urban habitat uninhabitable. As human populations grow and urban areas spread, other species are losing habitat, we are losing the benefits of intact ecosystems, and the interactions between people and animals are becoming battles. Between 1982 and 1992, over 2 million hectares of forestland and another 774,029 hectares of rangeland was converted to urban uses in the U.S. Urban expansion, combined with some forestry and agricultural practices, are enough to make habitat loss the leading cause of species extinction worldwide. (Zero Population Growth Reporter)

### **What are the costs of urban sprawl and the loss of our natural habitat?**

First, sprawl costs us all in dollars and cents. A 1992 study by the Center for Urban Studies at Rutgers University found that we pay a heavy "sprawl premium." Each new house will cost \$12,000 to \$15,000 more to serve with public facilities because of sprawled development than if development patterns were better planned. A 1996 study of the costs of alternative development patterns in Kitsap County, WA yields a similar result. It found that it will cost Kitsap taxpayers \$10 billion to serve the sprawl plan originally adopted by the County Commissioners. Other estimates with a more compact growth plan were four times less expensive, or in hard dollars \$10,000 less expensive with planned development. Such astronomical costs led the largest bank in California to conclude in a 1995 study that "Continued sprawl may seem inexpensive for a new homebuyer or a growing business on the suburban fringe, but the ultimate costs - to homebuyers, to the government, and to society at large-is potentially crippling." (1000 Friends of Washington)

Other costs of sprawl can't be expressed in terms of dollars and cents. Sprawl carries ugly strip malls (often with life expectancies of 10-15 years), increased air pollution, loss of woodland and wetland open space, and traffic jams. Streams are often channelized or piped, changing them from natural drainage areas into urban sewers. The vitality and desirability of our existing cities and suburbs suffer when these older communities are abandoned in favor of new sprawl development. The examples of South Florida and Southern California demonstrate what happens when sprawl runs rampant. Without planned urban growth areas, these regions consumed vast amounts of viable land until growth has respectively invaded both the Everglades and California desert. Housing prices in these regions are astronomical, and they face a host of physical, environmental and social problems. Overdevelopment is not just an American problem. Burgeoning

populations and constant demands for more services, more products, more living space is a worldwide problem.

### **Sprawl Is Everywhere**

Many cities, both in America and abroad, began their development after the invention of the automobile and the development of highway systems, which permit people to live further away from their place of work. Documents on the Internet indicate that communities in every country are dealing with the flooding and reduction of species habitat that result from uncontrolled urban sprawl. Jakarta, Indonesia suffers with uncontrolled urban sprawl. Ireland also must deal with over-development and the results of poor planning. CLONMEL Corporation has decided to review a hydrological survey carried out before work began on a main drainage scheme. The scheme has been blamed for the present floods, the worst in recent memory. Many of the floodplains surrounding the river Suir in the past had now disappeared because of over-development. (The Irish Times) Exactly how bad the sprawl is depends upon whom you ask. Land developers will tell you that their plans for paving paradise will result in much-needed housing, businesses that provide jobs, and means through which services and products are provided to a growing population. But they probably won't mention the flooding to come.

### **Resulting Flooding of Urban Areas**

As urban areas invade rural areas we destroy the functioning of ecosystems. Plants and animals provide us with "ecosystem services" that we often take for granted. For example, plants increase soil capacity to hold rainfall in their canopies and absorb it in their roots. When the plants are removed or paved over, rainwater moves more swiftly across the ground, thus increasing the chances of erosion, flooding, and pollution.

As West Sonoma County resident Mike Reilly calls for new policies acknowledging that development has contributed to Russian River flooding, research indicates that urbanization of watershed areas such as the Santa Rosa plain significantly increases the chance of floods. Penn State hydrologist Dr. David De Walle, studying how urbanization affects stream flow, says that communities built in watersheds can cause dramatic jumps in downstream runoff. As the hydrograph changes, peak flows increase in number and duration. "As the population increased, there was more flow into the streams and rivers," says De Walle. "When slightly higher flows from each subdivision are added together, the effect downstream can be significant." Residents along the Russian River recovering from the fourth major flood in three consecutive years might think such conclusions are obvious. But De Walle says that his EPA-funded study is believed to be the first of its kind. "There have been a great many studies of stream flow, temperature and precipitation, but they have all been done on undeveloped watersheds that are minimally impacted by humans," he says. "No one, to our knowledge, has formally looked at urban watersheds in this way."

De Walle is particularly concerned about what will happen in these areas when climate changes bring even more rain. Although scientists agree that the greenhouse effect is real, no one knows how that will impact flooding. "If the greenhouse effect causes global warming, everyone is pretty confident that temperatures will increase, but how much precipitation will change is hotly debated," he says. Combining population census

counts, precipitation statistics from the National Weather Service, and stream flow data, he is looking at four regions of the U.S. over the past 50 years. In each area, De Walle is comparing five urban watersheds with five rural watersheds.

Mike Reilly wants to study a possible link between development and flooding, and he said that the county needs to move forward and ask what kind of reasonable land use planning is necessary to prevent annual disasters because of over-development. Reilly sees Colorado as a model. "A few years ago, Denver had a \$300 million flood and a number of people died," he says. "Now planners work retention of water into their plans; there are rooftop gardens, and 18 inches of water is stored during storms. They've put parklands in low-lying areas," says Reilly. He also cites research already done by Rue Furch and Otto Teller, showing that Sonoma County has built its subdivisions in the most sensitive places possible. Environmentalists Furch and Teller were curious about the county General Plan, which claimed that only 3 percent of the county was developed. "Three percent doesn't sound like much, but it's interesting where it is located," says Furch. "Most of the roads, parking lots, and buildings are in the major recharge areas for our watershed." Dr. De Walle believes that watersheds will eventually be considered critical areas that should be protected. "Planners are starting to move that way all over the U.S," he says. (Elliott)

### **Hedging Our Bets: Are We Planning for Tomorrow?**

Unplanned development is expensive, inefficient, and frankly, irresponsible. We all try to plan ahead in our personal lives. Why should we expect anything less from our own communities? We ask nothing more or less from our leaders than we ask from ourselves: stop and think about what kind of a community we want, plan ahead for that goal, be flexible with new technology, and be smart about how you get to the goal.

Not only are we not being smart about planning for our futures....we're not planning at all! Discussions with government agency representatives, private sector contractors and engineers indicate the glaring truth is that very few are planning for tomorrow's development and the impact (both immediate and long-term) those changes will make on the projects being constructed today. When we "pave paradise and put up a parking lot," the rain that used to soak into paradise's soil and nourish its vegetation now runs off into ditches and culverts. If the drainage ditch runs to a culvert designed for the runoff from the cornfields that used to be a paradise for multiple species, today's rainfall may overwhelm the culvert and destroy the roadbed. This cycle only gets worse when the next development occurs upstream.

"Buildings, and the roads that connect people to their destinations, not only pave over habitat, they divide it. Habitat fragmentation - dividing living space into smaller patches - has the effect of creating "islands" of habitat within seas of disturbed land. Animals and plants need varying amounts of habitat to survive; even areas designed to protect species may not be sufficiently large for all species. (Wolf)

"Bye-Bye, Suburban Dream," mourns the cover of Newsweek's May 15 issue. The article inside contends that sprawl is what's wrong with America and offers fifteen ways to "fix" the suburbs. But before we all declare victory and go home, we ought to have a closer look at what we actually do and don't know about this dream deferred. Sharpening our

understanding of the problems of sprawl has been a significant task, largely because it encompasses such a diffuse sweep of issues that the term "costs of sprawl" means different things to different people. To a developer, it might mean the cost of manhole covers and curbs. To an environmentalist, it may refer to the loss of wetlands or the poor air quality that results from high levels of driving. Sociologists may find suburbs alienating, especially for low-income individuals. And for local and regional governments, sprawl is often part of the discussion about how the weakened fiscal capacity of urban areas drives residents to more financially sound pastures.

Planners, of course, worry about all of these factors, particularly how to ensure that a region's ability to maintain services, quality of life, and contain costs is not hampered by the forces of decentralization. They may not have to wait much longer for some real answers. Although the exploration of urban sprawl as a subject of empirical or even theoretical research has been limited, we are beginning to understand more and more about how the universe of sprawl costs are interrelated and affect each other. In the process, we have learned that the time to step up our research efforts on the costs (and benefits) of sprawl is long overdue.

We need to gain a better understanding of the costs of operating and maintaining facilities during their entire lifecycle, which would better enable us to understand the long term costs of infrastructure investment and sprawl. Beyond asphalt, pipes, and buildings, there are hidden costs, such as environmental costs-especially those believed to be a function of increased driving or the consumption of land and habitats. Though many studies have examined these costs, almost none have effectively addressed sprawl-specific costs.

Dave Palmer, a Washington State homeowner, said, "Money cannot stop water. The only appropriate and cost effective mitigation for floods is to limit further floodplain development. People like me, who were dumb enough to buy permitted property in the floodplain, will have to bite the bullet. Will I like it? No! But is it reasonable to build a dam or levee to protect me when that same dam or levee will flood my downstream neighbor? Is southwest Washington really going to be divided into two more nations - Dry and Wet? How can this proposal be taken seriously? I've organized, sat in on, and have participated in attempts to initiate regional flood planning. Unfortunately no regional flood planning is taking place. In my opinion none of the elected or appointed local government representatives wants to consider any solution outside of their realm of influence. None of the three Chehalis river counties wants to limit development in the flood plain for fear or risk of losing growth from future development, even though that growth will come at a terrible price to all who suffer, and they will suffer, because the river always wins. So far the river has been kind. We have only lost property or animals. Will the river be so kind next time? Will that young family who buys a new home in the floodplain get their children out in time? Will our leaders, the developer, the builder and the tax collector be able to face the parents who lose a child in the next flood?

*Remember, the river always wins. "*

Creating a plan is not as simple a venture as it may at first seem. There are politics to consider, legal issues to wrangle with, cultural and racial biases to be resolved, as well as the emotional reactions by some community members. A Skagit County man who has studied flooding patterns for 17 years said he would be "very concerned" about forming a

flood control district for Lewis County. Larry Kunzler is an investigator for a Seattle law firm, and he recently spoke at a Chehalis River Council-sponsored event. The Flood Action Council has proposed forming a district in West Lewis County. Council members say their proposed flood control measures could lower flooding in the Centralia and Chehalis areas by up to 5 feet. Proposed measures include building a flood control dam on the upper Chehalis River, removing part of the "hump" on the Chehalis River near Centralia and installing a flood-control gate on the Skookumchuck Dam in Thurston County. In a wry, humorous speech, Kunzler explained the history of flooding in the Skagit Valley area. Glaciers and nearby volcanoes played a key role shaping the region and contributing to floods, rerouting the Skagit River, he said. Kunzler said Lewis County's flood problems are different from Skagit County's, but he advocated similar measures in both areas to minimize damages from flooding.

Government should do the following, said Kunzler, an investigator for a Seattle law firm who recently spoke at a Chehalis River Council-sponsored event:

- Allow farmlands to flood and compensate farmers for storing the stormwater.
- Stop development in the floodplain.
- Use wetlands as storage areas for floodwaters.
- Use shorter levees which don't pose as great a safety risk if they break.

"Let some of these wetlands flood," Kunzler said. "That's what God put them there for - it's a big sponge." Kunzler punctuated his speech with humor. "Flood control - I always thought those two words went together about as well as military intelligence, government organization and jumbo shrimp," he said.

The Society for Ecological Restoration advises that plans for restoration projects should contain, at a minimum, the following items:

- A baseline ecological description of the kind of ecosystem designated for restoration that accounts for the regional expression of that ecosystem in terms of the biota and poignant features of the abiotic environment.
- An evaluation of how the proposed restoration will integrate with other components of the regional landscape, especially those aspects of the landscape that may affect the long-term sustainability of the restored ecosystem.
- Explicit plans and schedules for all on-site preparation and installation activities, including plans for contingencies.
- Well-developed and explicitly stated performance standards, by which the project can be evaluated objectively.
- Monitoring protocols by which the performance standards can be measured.
- Provision for the procurement of suitable planting stocks and for supervision to guarantee their proper installation.
- Procedures to expedite promptly any needed post-installation maintenance and remediation activities.

### **Impact on Streambanks**

Torrential rain strikes paved roads, parking lots, airport runways, and urban concrete forests of sky-scraping buildings; it must run somewhere. With the agricultural lands rapidly disappearing beneath asphalt, and Earth's holding tanks and filters - the wetlands - being drained for development of condos and outlet malls, the water has fewer and fewer paths to follow for drainage. Urban streams are imprisoned in pipes, giving developers access to more land and reducing even further the available runways for the water. The few paths yet open, picturesque streams allowed to flow through parks and residential areas, are inundated with fast-moving water that rapidly spills over the banks.

Individual homeowners, park management, and many government agencies struggle to repair the damage that results from burgeoning water volumes in these streams, and in some cases preventive measures are sought and implemented to protect these fragile waterways from tomorrow's developments.

Manufacturers of erosion control work steadily to create products that can withstand ever-rising flow velocities and shear stresses while remaining cost effective. Though concrete and rocks can move water along fairly expediently in most cases, these treatments are finding less and less acceptance in the marketplace. The "hard armor versus soft armor" battle being waged by the manufacturers of RECPs (rolled erosion control products) and by practitioners of soil bioengineering is gaining momentum and gaining supporters amongst the specifiers.

Soft armoring - the use of natural and synthetic fiber structural supports and erosion control in conjunction with the similar traits of strong vegetative root matrices - provides a path for the water, a means of improving water quality, and habitat for many species; hard armoring provides none of these benefits.

### **The Riparian Zone - Where Human Action Alters the Course of Nature**

From the air, the edges of a stream appear as bright green tracks furrowed into the forest floor. That's because grasses, shrubs, and trees flourish in the damp, fertile soil of the banks and floodplains that border the stream. This is the riparian zone, a protective margin of vegetation that keeps the water clear and cool for the creatures in and along the stream. It is also important to almost all of our forest animals, which come not only to drink, but also to find food, shelter, hiding places, and others of its kind. In summer, shade from the vegetation along the water's edge moderates temperature, humidity, and light. In winter, thickets of trees and vines buffer the area from harsh winds. This provides a protected habitat for many woodland animals.

Alder, maples, willows, and many other plants stabilize the streambanks and prevent erosion from storms and snow melt events. Their leaves intercept much of the rain before it reaches the ground, returning it to the atmosphere as water vapor. Stormwater runoff carrying potential natural pollutants such as silt, nitrogen, and phosphorus, is absorbed and used by the plants before it enters the stream. Soils also store excess water underground, releasing it slowly over time to prevent downstream flooding. Pesticides and other human-generated pollutants may be retained by the soils long enough for bacteria to break them down into harmless compounds.

Birds build their nests in trees and shrub thickets along the bank from mud and twigs gathered along the shore. They feed on the seeds, berries, and insects of streamside vegetation. Deer and moose come to the stream to drink. In winter, they travel its frozen corridors to their feeding grounds and use its sheltered valley as a stronghold. Weasels, mink, skunks, and mice scurry beneath the shade of the streamside forest to avoid the notice of owls, hawks, and other sharp-eyed predators. Night-prowling raccoons leave tiny leprechaun footprints in the muddy banks as they hunt for crayfish and freshwater mussels. Predatory fish like trout and salmon quickly devour flying insects that drop into the water from overhanging branches.

Ultimately, the largest fish in a river is dependent on leaf litter from the riparian zone. An alder leaf that is swept into a stream in Eustis is broken down and recycled as it moves downstream. It feeds an insect that soon is gobbled by a small fish which eventually is eaten by a trout that in turn nibbles at the hook of a fly fisherman on the lower Kennebec. Here in the riparian zone conflicts often arise because private property, the streambank, abuts a public resource, the water. What we do on our own land affects what happens far beyond our property line. Even a narrow gash in the riparian zone, made by a stream crossing for cows, a log skidder, or an all-terrain vehicle, opens the stream to runoff of silt and pollutants from the land. Silt clouds the water, clogs and scratches the delicate gills of fishes, and smothers aquatic insects and fish eggs. A build-up of silt makes the riverbed more shallow and prone to overflow its banks in a heavy storm. Phosphorus, nitrogen, and other nutrients washed in with the soil cause noxious "algae blooms." Where trees and shrubs have been cleared entirely from the water's edge, erosion turns the stream mud brown. Without a shady canopy, the water becomes too warm for fish like salmon and trout. If the food supply of leaf litter and falling insects stops, many aquatic animals either starve or move to a more favorable environment. When we breach this wall of vegetation we begin a chain of destruction that threatens habitats, food chains, and the quality of the water far downstream.

### **Taking Today's Stream Projects into the Future**

The plethora of available information lends to the inescapable conclusion that (a) planning for future development is crucial; (b) few responsible parties are actually including the future in their planning process; (c) projects are failing and will continue to fail due to this lack of foresight and initiative; and (d) retrofits have become a fact of life, and these costs alone may increase the sense of urgency to plan well and to plan ahead.

The Rouge River, Michigan area is one community that is planning ahead. What their watershed planning/management and ecosystem-based management are trying to accomplish is to comprehensively address contaminant (e.g., point and non-point sources, contaminated sediment remediation), physical (e.g., flow augmentation, streambank stabilization, physical habitat modification), and biological (e.g., stocking/harvesting, wetland restoration and enhancement, food web manipulation) management alternatives that will achieve locally-based, ecosystem goals. Such site-specific, ecosystem goals are established based on ecosystem characteristics, public needs, and scientific, regulatory, and resource management input. Historically, many people have believed that when

environmental concerns win, economic concerns lose, and vice-versa. We now know this is not the case when planning is well integrated. Watershed and ecosystem-based management provide a balance among environmental, economic, and societal issues, forming win-win situations. Good stewardship is simply good economics.

Other communities are adopting this “look to the future” philosophy as it applies to dealing with urban sprawl, flooding, and waterway damage. One of the ways that some urban areas, notably Portland, Ore., contain sprawl is by drawing a circle around the metropolitan area and limiting development outside it. Urban growth boundaries in Oregon have not been used to stop development, but to redirect it within existing urban areas," says Scott Chapman, chair of the Columbia Group's land use and transportation committee. Legislating such boundaries is a daunting challenge, however, because most urban areas comprise dozens of cities and several counties that are sometimes competing for development dollars. Unless the state steps in, as it did in Oregon, growth limits can only be realized in a piecemeal fashion. Without urban growth boundaries, farmers and other landowners on the periphery of developed areas are often under tremendous pressure to sell their land, which is worth much more as a potential subdivision than as a farm or natural area. One innovative way of addressing this is for the community to buy the development rights from landowners, so that the incentive to sell out to developers is no longer there.

Another obstacle to preserving farmland outside towns and cities is the pervasive myth that development along the periphery increases revenues for local governments. In reality, many communities see property taxes rise in response to the increased costs of roads, fire departments, sewers, schools and other critical government functions. The Sierra Club Midwest is calling for a "property tax impact statement" akin to the environmental impact statements required for many developments. "We're just asking for truth in advertising," says Hulse. "If taxpayers realize they're paying millions of dollars to subsidize sprawl, they're more likely to support cost-effective urban development." The Maryland Chapter has adapted the Sprawl Costs Us All model for their state, giving an "Ostrich Award" to 14 counties that do not track the costs of development to taxpayers. "These counties have their heads in the sand," says Janet Pelley, principal author of the report. "Sprawl development in Maryland costs more to service than it pays in revenues." (The Planet) One innovative way of addressing urban growth boundaries is to buy the development rights from landowners, so that the incentive to sell out to developers is no longer there.

Craig Fischenich, Ph.D., P.E., Research Civil Engineer, U. S. Army Engineer Waterways Experiment Station, says, "On the issue of future conditions, I believe that accounting for future conditions is one of the actions that separate true erosion control professionals from run-of-the-mill practitioners. Proper techniques must be selected and designed on the basis of the environment in which they will function, and that includes the future environment. After all, we don't implement erosion control and streambank runoff management measures to just see us through another day. We expect them to have a reasonable life - generally 10 to 20 years or longer. I'm always shocked to hear a designer, when describing a project, say "It was working just fine until we had a flood, then it failed." I've heard dozens of analogous comments relating to erosion migration, scour, channel degradation, beaver dam failure and the like - the notion being that these

"acts of nature" are beyond the control of the designer and thus cannot be accounted. Though the acts themselves may be beyond the control of the designer, anticipation of their occurrence and assessment of their impact should be a significant design consideration. The magnitude, frequency, and duration of high flow events and the associated sedimentation processes must be understood to properly select and design an erosion control project. Our projects tend to be located in environments where discharge and sediment yield are changing as a consequence of land use modifications. We must strive to anticipate these changes and assess their implications. If you construct a bank stabilization project on an urban stream that will degrade three feet in the next 15 years, how will your project perform? If you didn't account for the degradation the project will likely fail. Some argue that future conditions are highly uncertain and that our predictive capabilities limit the extent to which we can quantify environmental stresses 10 years down the road. Yes, we must deal with uncertainty in projecting future conditions. But our characterizations of existing conditions also contain uncertainty. A considerable body of research is currently directed at quantifying variability, uncertainty, and risk and I think in the next few years we will see better guidance on how to incorporate these notions into our designs. Given the option of assessing a stream's future physical character and designing a project to coincide with those conditions or designing a project based upon strict empiricism and an assessment of today's condition, I'll take the former every time."

As the value and use of land near streams increases, the need for effective bank protection techniques quickly becomes apparent. Many miles of streambank along major waterways have been protected as part of navigation and flood control projects; however, many streams still need bank protection. Methods currently used include:

### **Redirectional Bank Stabilization Methods**

- Bendway Weirs
- Vortex Weirs
- Upstream Angled Chevrons
- Deflectors
- Kickers
- Vane Dikes

### **Resistive Bank Stabilization Methods**

- Articulated Concrete Mattress, Bank Paving, Interlocking Paving Materials, Gabions, and Riprap
- Longitudinal Peaked Stone Toe Protection
- Willow Trees and Posts
- Segmented Block Walls
- Jacks
- Groins, Dikes, and Pilings
- Natural Features such as Hard Points
- Soil Bioengineering Techniques that are based on sound engineering practice and ecological principles which focus on soil and vegetation

### **Zoned and Blended Schemes**

- Longitudinal Peaked Stone Toe Protection
- Willow Trees and Posts

### **Grade Stabilization Structures**

- Natural Controls
- Exposed Pipeline Crossings, High and Low Drop Structures, Drop Pipes, and Bridges and Culverts
- Fallen Trees
- Newbury Style Rocked Riffles
- Upstream Angled Chevrons

Information about these measures is easily available on the Internet, from manufacturers, distributors, contractors, engineers, architects, and consultants. The membership lists of the International Erosion Control Association, the American Society of Landscape Architects, the Society for Ecological Restoration, and the North American Lake Management Association, amongst others, are excellent resources for this information. The Web pages for the American Society of Civil Engineers, the US Army Corps of Engineers, the Waterways Experiment Station, the Department of Natural Resources, the Environmental Protection Agency, and other government agencies are also resources for information about these measures for streambank protection. (See chart.)

## **Here Is What We Are Doing**

### **Retrofit Case Studies**

#### **Illinois**

"The Illinois Department of Natural Resources, in cooperation with the Cass County Soil and Water Conservation District and the Natural Resource Conservation Service, is undertaking a unique, long-term stream stabilization and erosion control project at the Site M State Fish and Wildlife Area in Cass County, Natural Resources Director Brent Manning said today. "Management of the Panther-Cox Creek Watershed, along with construction of a medium-size lake and several smaller lakes, are among our top priorities in protecting and developing Site M," Manning said. "The watershed stabilization work now underway will not only enhance this ecosystem, but will serve as a model for stream and river basin stabilization projects statewide." Work crews have stabilized several severely degraded segments of Panther and Cox creeks near their confluence in an area located in the northwest corner of Site M.

"When we first surveyed the creeks in 1994, we found that decades of bank slumping and collapse had caused 15 to 20 feet of bank to be lost into the stream," said Jim Mick, Department of Natural Resources Streams Program administrator. "With the help of our Illinois State Water Survey staff, we chose a restoration technique often used in Canada that virtually rebuilds the creek bed and stream bank, protecting them against future degradation."

The stream stabilization consists of three main components:

- **Installation of in-stream "lunker" structures, large wooden boxes partially buried near the base of the stream bank that stabilize the bank "toes," the lowest portion of the**

bank where it meets the stream bed. The lunger structures also provide fish habitat and concentrate fish for anglers.

- Grading of the stream bank to reduce slope, and the planting of dormant willow posts to stabilize the upper portion of the bank and, eventually, to provide shade.
- Construction of rock "riffles" in the streambed, which provide a lasting foundation for the streambed, help control water flow and prevent further deterioration.

The initial phase of work on the stream stabilization project involved several locations along an 1,800-foot section of Cox and Panther creeks. Project planners hope to do more riffle construction, lunger installation and stream bank stabilization downstream on the creeks in future years as funding allows. Stabilization of the Cox and Panther creeks should allow for flooding of traditional floodplain areas in the northern part of Site M, improving natural species plant growth prospects and wildlife habitat. The project also includes relocation of the nearby Creek Road and planned construction of a bridge near the low-water ford on Cox Creek. A surfaced trail is to be built to connect a scenic overlook for the project site and the surrounding Cox Creek Hill Prairie Natural Area to the Creek Road equestrian trailhead in the northernmost section of Site M. Other Site M watershed improvements include riparian floodplain plantings, terracing, riprapping and installation of dry dam berms and other water control structures to reduce cropland erosion. The Department of Natural Resources and the Illinois Department of Agriculture are cooperating in a multi-year study of soil erosion abatement techniques and sustainable agriculture farm management practices on Site M property.

Approximately 5,000 acres out of the 15,574 acres which comprise Site M are being used for agricultural crop production. The DNR is working with the Department of Agriculture, the Natural Resource Conservation Service, the Cass County Soil and Water Conservation District and neighboring landowners on all elements of the ecosystem-based watershed management and development plan for Site M.

## **Oregon**

Leatherman Tool Group, Inc. is proud to be partnering with the City of Portland Bureau of Environmental Services and The Wetlands Conservancy to restore the natural habitat around the Columbia Slough. Leatherman Tool Group is providing the funding for the restoration of the streambank. Students from C.R.U.E. (Corps to Restore Urban Environments) will create a plan for the landscape and the planting of native Northwest trees, shrubs and flowers. C.R.U.E. is an alternative high school program that receives their training through Open Meadow Learning Center and The Wetlands Conservancy. The program teaches at-risk youth about the environment and work skills in restoring the landscape by planting the right kinds of wildlife that fit the needs of the community. C.R.U.E. works in partnership with government agencies, individuals businesses and non-profits to develop and rehabilitate our natural landscape.

Steve Berliner, partner and co-founder of Leatherman Tool Group, has been instrumental in the restoration project on the Columbia Slough. Heavily involved in stream and wetlands preservation, he is currently the director of Friends of Kellogg and Mt. Scott Creeks, a community-based, non-profit organization. He serves on several Clackamas County technical advisory committees on water resources and community planning.

The project will rehabilitate a minimum of five miles of the Slough by 1998. The project started two years ago when the first group created a restoration plan for 250 feet of the slough. The second crew of students started by removing exotic blackberries and planting native trees and scrubs behind Atlas, Copco located to the east of LTG. In April, C.R.U.E. started removing blackberries and other non-native plants from behind Leatherman Tool Group. They will be planting 434 native plants along the streambank, the length of LTG's property. There will be a hiking trail put in by the City of Portland that will connect to an existing trail at northeast 92nd at the airport. This trail is part of a larger plan by the City of Portland. The plan has been in the works since 1903.

### North Carolina

A 4,650 foot section of Little Sugar Creek in the Huntington Farms Park area in Charlotte, North Carolina requested stabilization, habitat restoration, and flood control. This linear park is predominately in a residential neighborhood. It is owned by the City of Charlotte and maintained by Mecklenburg County Storm Water Services.

Like most other streams in Charlotte, Little Sugar Creek was channelized to improve drainage in the early 1900's, and it has been dredged and snagged several times since then, often leaving the channel without any vegetative cover on its banks. The stream drains much of eastern and central Charlotte, and the watershed is highly urbanized. The frequent flooding and high peak discharges caused significant bank erosion and channel enlargement. The immediate area had also been used as a constructed landfill in the past. At several locations, bank erosion had uncovered construction debris burial sites containing tree trunks, waste construction materials, and miscellaneous organics.

An interdisciplinary team including hydrology, surveying, and geotechnical expertise, aquatic science, fluvial geomorphology, and soil bioengineering was assembled to assess the site and to develop solutions to reach the multi-objective restoration and stabilization project goals. These goals included: bank stability, erosion protection, flood protection, aquatic habitat enhancement, water quality and aesthetic and recreational improvement, community education, and economic savings.

Design studies were initiated in April 1996, producing conceptual alternative designs with costing information. Initially erosional bank failures along the creek were evaluated, typed and matched with appropriate solutions. From this, final plans and specification documents were prepared. Riprap rock was reduced along the toe and in some cases was completely eliminated. This dramatically reduced the project costs. Construction was completed in March 1997.

Soil bioengineering methods including live fascines and brushmattress were employed in different configurations along the banks. The project received an early flood event prior to construction completion. Four months after installation, Little Sugar Creek received a flood that exceeded the 100-year event. The project sustained no damage. While this project is still a very new installation, to date it has become well vegetated, offering enhanced riparian benefits, overhanging cover, aesthetic improvements, and bank stability. Banks appear stable and are aesthetically pleasing. The instream habitat structures (current deflectors and rocks) have also been performing well, having produced

a variety of scour hole cover and resting areas for fish. The project will continue to be monitored over the next few years to track its performance.

## WHAT ELSE CAN WE DO TO PROTECT OUR STREAMS?

### Best Management Practices

Sometimes common sense is the best option in choosing sustaining plans for streambank erosion. The feasibility of using water troughs for grazing cattle as a Best Management Practice (BMP) in reducing streambank erosion, nutrients and bacteria from pasturelands was investigated. A year long study took place on three head headwater streams on two commercial cow/calf operations in southwest Virginia which use rotational stocking. Observations of cattle behavior were performed in order to describe the effectiveness of the BMP in reducing the time which cattle spent in the stream area. Estimates of streambank erosion and water quality were taken on a biweekly basis. An economic analysis comparing the costs and benefits of installing off stream water sources as an environmentally sustainable BMP with streambank fencing was also performed. Results of this study show that the BMP was 91% effective in reducing the time which cattle spent drinking from the stream. Results also show that streambank erosion and of total suspended soils loading was significantly reduced when cattle were given access to an off stream water source.

### Greenways and Rails to Trails Programs

Rails-to-Trails Programs are not only a beautiful way of preserving a part of our country's history, they're also ideal for all kinds of outdoor activities, including walking, biking, in-line skating, horseback riding and cross-country skiing. The Rails-to-Trails Conservancy has completed 680 trails so far, totaling almost 8,000 miles in 48 states, and another 900 Rails-to-Trails are in the works.

Many railways that were established over 100 years ago have been abandoned. These railway corridors are in danger of being lost to future transportation or other public uses. Surplus railways need to be preserved. This can be done through interim use as greenways and trails.

Unlike parks and community gardens, which can have a significant, but limited, impact on a community, a greenway has the potential to affect and link an entire region. A greenway is defined as an open corridor that provides connections between other green spaces, usually including a combination of paths, bike trails, urban riverside, ecologically significant natural corridors and scenic and historic routes. Taken together, these spaces form a network that connects different communities--and even cities--in a web that is not accessible by car.

Behind the greenway effort is the concept of regionalism, looking at cities and suburbs as a whole, pooling taxes and other funds together, and in the process creating larger open spaces. Abandoned farm land, railroad tracks and stream corridors are among the most common types of land used for greenways, as they provide a thread from rural to urban communities.

In Washington state, for example, the Mountains to Sound Greenway links Puget Sound through the Cascade Mountains to eastern Washington, a total of 90 miles that includes Seattle. Thanks to the greenway, a commuter can ride a bicycle from downtown to home or to a weekend cabin getaway.

In addition to making the Seattle region more bike-friendly, the corridor kept much of this land from becoming a suburb to Seattle, says executive director Nancy Keith. "Our goal was to protect this land from turning into a strip mall," she says. A combination of public and private sector organizations usually work together to secure the land to create these corridors--in the case with Mountains to Sound, timber companies joined forces with local government, environmentalists and private businesses."

The goal of the Arlington, Virginia-based American Greenways Project is a national greenway network, and while that vision may still be years away, states such as Washington and Illinois have already made their regions viable participants. "The Northeastern Illinois Regional Greenway Plan is one of the most ambitious examples of a greenway plan," says Ed McMahon, director of the American Greenways Program.

The Northeastern Illinois Regional Greenway Plan, proposed in 1990, maps out 1,600 miles of greenway in Chicago and the surrounding counties, connecting a combination of 900 miles of stream-related greenways, 350 miles of converted, abandoned rail corridor, and 330 miles of other land, including Lake Michigan shoreline both in and outside Chicago.

To date, more than 720 miles have been acquired. The system exists due to the cooperation of more than 200 municipalities in six counties, The Northeastern Illinois Planning Commission and nonprofit groups like the Openlands Project, which initiated the plan.

Uses of the Northeastern Illinois Regional Greenway Plan are as diverse as the communities it serves. In north suburban Skokie, the Chicago River flows through the community, providing a structured educational site called the Skokie Lagoons. In suburban Crystal Lake, a bicycle trail made from a converted, abandoned rail corridor runs through town alongside two supermarkets.

"Every spring, summer and fall I see people riding their bikes to do their grocery shopping. This is something traffic engineers never thought would happen in the United States," says Ders Anderson, greenways director of the Openlands Project. These spaces also offer safe areas for children to bike within the confines of the city, such as along Lake Michigan, as well as routes for in-line skating and jogging and commercial opportunities for arts and crafts, restaurants and related retail.

The expanse of the trail system of the Northeastern Illinois Regional Greenway Plan should grow even more, Anderson predicts, provided Congress approves continued funding of the Intermodal Surface Transportation Efficiency Act, which provides federal money for alternative transportation modes. "This year we're expecting additional mileage to be added, particularly from Will County, in the form of major stream systems and possibly some rail corridors," he says.

Anderson also is looking forward to the approval of a grant for the Burnham Greenway, which will link 12 miles of wetlands, sand prairies and wooded areas to heavily industrialized and residential communities near the Indiana border. The Burnham Greenway, which requires the joint efforts of the Chicago Park District, the Cook County Forest Preserve, the Chicago Department of Transportation and three other local government organizations, will give the mostly working-class neighborhood alternative commuting options to factory jobs, as well as link otherwise isolated wetlands to the community.

As a tool for furnishing recreation, Anderson says the greenway is a success. "When you are in the business of government you need to find ways to provide recreation facilities where you'll satisfy demand and get the most bang for your buck," he says. In Illinois, the system gives city-dwellers more access to nearby suburban land, and suburbanites an in-the-city outing besides the theater.

But while recreation is a key benefit of the vast greenway system, the ecological one is perhaps more urgent. "There has been little appreciation by the general public of the biodiversity in this region," Anderson says; something he hopes will change as the greenway becomes more accessible. City residents will learn more about where their natural resources come from and how they work within an urban structure. And habitat protection and water quality assurance are part of the of long-term goal of protecting these open spaces.

Adds Anderson: "A greenway is one of the most cost-effective ways to do these types of protection programs because nature is doing the preservation work herself."

### Education

All levels of education must reflect the reality that modern human society is having an unprecedented and detrimental impact on natural ecosystems, and consequently on human society itself. The role of human activity in creating and accelerating the current environmental crisis indicates a prior problem in how we educate students in our colleges and universities. Conventional approaches to education emphasize linear, compartmentalized thinking which rewards the narrow, parochial perspectives we saw on display at the Kyoto conference. Such an approach is no longer tenable in the face of complex environmental issues which threaten the security and survival of human society and natural ecosystems. By contrast, interdisciplinary thinking, teaching and research sharpen one's awareness of connections and contradictions and, therefore, must become a priority throughout higher education. If we hope to realize just and effective solutions to this crisis, graduates must emerge from our schools with the ability to design economic and social strategies that keep our life-support systems healthy and intact. (Second Nature)

### Eco-Industrial Parks

An eco-industrial park is a community of manufacturing and service businesses that work together to improve their environmental and economic performance. The local community benefits from the resulting improvements in its environment and from the creation of new jobs. The firms in an eco-industrial park work together to reduce the use of raw materials, reduce outputs of waste, conserve energy and water resources, and reduce transportation requirements. Global Environmental Options is a non-profit

organization which focuses on creating sustainable buildings, communities, and national parks through a unique combination of global electronic resources and local hands-on initiatives. GEO seeks to restore a balance between the natural and human environments through a whole systems approach to design, planning and education.

### Conclusion

Dr. Pat Jacoby, tenured professor at Purdue University's North Central campus, includes in her business courses an exercise in planning for the future. She instructs her students to predict development and changes in their local communities. The student must turn in a detailed map showing their predicted changes as well as a paper describing these changes and their opinion as to why these changes will occur. Over the years, the accuracy of the student predictions is amazing. College sophomores and juniors, the majority of whom have no civil engineering or master planning backgrounds, use common sense to predict development in their communities. Their maps have accurately predicted new shopping areas, high-density residential developments, new streets and sewers, new underground utility wires, and other facilities such as airports, landfills, and hotels. If untrained college students majoring in business can predict development in their communities with astonishing accuracy, it seems reasonable to believe that professionals can predict such changes as well.

### Where Do We Start?

Project designers can:

- Form partnerships with people and agencies to create sustainable designs.
- Contact city officials, prior to any design efforts, to determine if any development is planned for the surrounding area.
- View maps of the surrounding area and predict "common sense" changes that will likely occur within the next 10-20 years.
- Consult a fluvial geomorphologist to predict future actions of any nearby rivers and streams.
- Gather weather data for the area and consult local meteorologists about weather predictions - is increased moisture predicted over the next ten years or is the moisture level likely to drop?
- Design their projects to withstand runoff from increased development near the project, to provide habitat for species living in the area, and to grow stronger over time through vegetative root mass.

Zoning Boards can:

- Work with state Floodplain Managers to determine where the floodplains are in their area.
- Designate those floodplains as "no build" areas.
- Develop plans for their community that clearly outline where development can occur and where greenways will be created.

Property owners can:

- Provide alternate drinking sources for livestock, protecting delicate streambanks from high traffic, soil compaction, vegetation destruction, and erosion.

- Keep wetlands in good condition, utilizing them as filters and storage for stormwater runoff.
- Plant trees, shrubs, and vegetative cover to protect their soil and to provide habitat for a variety of species.
- Become involved with their local zoning boards and planning commissions, helping direct the future changes in their communities.

Through good planning, we can protect our designs and projects, and we can protect our futures.

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