URBAN WETLANDS FOR STORMWATER CONTROL AND WILDLIFE ENHANCEMENT

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INTRODUCTION

WHAT IS URBAN STORMWATER?

Urban stormwater is defined here as surface runoff, generated by rainfall (and to a lesser extent, snowfall), which enters natural drainage systems like streams and rivers by overland flow or through storm drains. Urban development, resulting in much of the land covered by buildings and pavement, increases the extent of impervious land surface over pre-development conditions. Buildings, pavement, and the loss of vegetation eliminate much of the land's natural storage capacity for water. This results in greater post-development runoff and earlier peak flows. Higher peak discharges, if uncontrolled, can often lead to major flooding problems downstream.

Undeveloped land absorbs much of the water which falls during a rainstorm.

WHY SHOULD URBAN STORMWATER BE CONTROLLED?

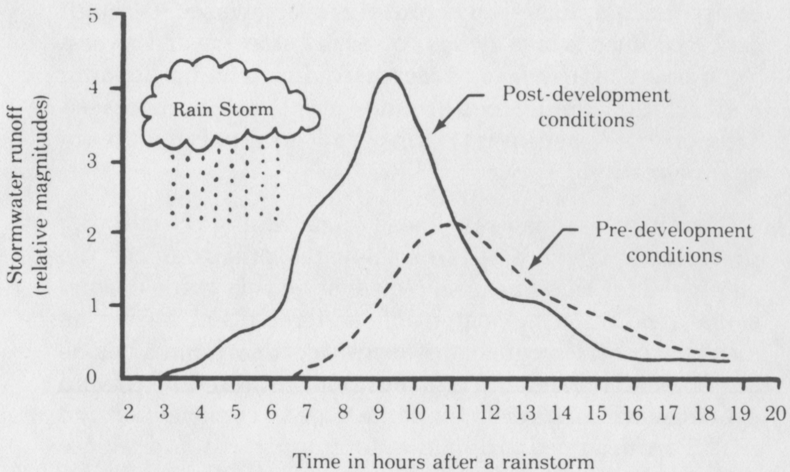
Uncontrolled urban stormwater can lead to increased downstream flooding and pollution, diminished groundwater supplies, increased erosion and sedimentation, extensive alteration of stream channels, and damage to aquatic wildlife or wildlife habitat.

Controlling stormwater *quality* is now considered by many experts of equal or greater importance than the control of the *quantity* of stormwater. Researchers have learned that urban stormwater may contain numerous "pollutants", with suspended solids (i.e., sediment resulting from soil erosion), the "nutrients" nitrogen and phosphorus, and heavy metals generally being of most significance.[13] A California investigator found that in newly developing areas, construction-related erosion increased soil loss 15 to 20 times, and in one watershed in Santa Clara County, 72% of the sediment leaving the area originated from 6% of the land area.[8] The Soil Conservation Service has estimated that more than 25,000 tons of soil may be eroded from a 1 square-mile area undergoing urban development.[14] Losses of soil from construction sites may range from 30-750 tons per acre per year.[9] Such erosion has two major negative effects. One, topsoil is lost, which reduces soil productivity, and two, sediment in waterways can cause enormous disturbances to aquatic ecosystems. For example, sediment:

- scours and abrades stream channels,
- reduces light available to primary producers (i.e., plants),
- covers fish spawning sites,
- clogs the filters of mollusks (like clams and oysters),
- limits sight of predators, and
- buries benthic (bottom-dwelling) organisms.

Losses of soil from construction sites may range from 30-750 tons per acre per year.

Urbanization increases the amount of impervious land surface which results in less water infiltrating to replenish groundwater supplies.



Urbanization results in greater runoff from a site. Stormwater runoff, if uncontrolled, can often lead to major flooding problems downstream. (Schematic.)

Sediment resulting from soil erosion is often a major "pollutant" in stormwater from urban or urbanizing areas.

USDA - Soil Conservation Service

Nitrogen and phosphorus are plant nutrients and high levels of both are often found in urban runoff. Lawn fertilization is a primary source of both nutrients. Excess levels of nitrogen and phosphorus in waterways can stimulate rampant, unwanted aquatic plant growth, particularly algae, which can have detrimental effects on other components of the aquatic system.

Heavy metals in urban runoff may include lead, zinc, arsenic, silver, cadmium, mercury, chromium, nickel, copper, and iron. Many of these are washed into waterways from roads and streets and originate from vehicles (tire wear, exhaust, etc.), pavement, street marking paint, and from commercial and industrial developments. Heavy metals can be toxic to aquatic and terrestrial organisms, including man. Generally, those of most concern are lead, cadmium, and mercury.

Biochemical oxygen demand, or B.O.D. for short, may be high in stormwater runoff from urban areas. B.O.D. is a measure of "oxygen demanding" organic matter in the water. Organic matter, through decay and decomposition, may consume large amounts of the dissolved oxygen in the water with the result that insufficient oxygen remains for fish and other aquatic organisms. Organic matter is often attached to sediment particles. By controlling sediment, one can control, to a large extent, B.O.D. in urban stormwater runoff.

Other constituents of urban runoff may include salts from roadway deicing compounds, pesticides from lawns and gardens, automotive oil and grease, and bacteria and viruses.

URBAN STORMWATER CONTROL

Past urban stormwater management practices often sought rapid runoff at new development sites. This was easily accomplished by routing stormwater through concrete-lined storm drains to nearby streams and rivers. Such practices can lead to increased downstream flooding and pollution, diminished groundwater supplies, increased erosion and sedimentation, and extensive stream channelization.

Currently, emphasis is placed on detaining or retaining precipitation where it falls. Several practices can be employed for this purpose. However, in this guide discussions are limited to detention and retention basins as means of controlling urban stormwater runoff. Such basins are presently popular in modern stormwater control and probably will remain so for some time to come. *Detention basins* are designed to detain water temporarily and release it slowly to a receiving body of water. They are usually dry or muddy between storms. *Retention basins,* on the other hand, are designed to retain water permanently.

Early detention basins were designed to reduce flood hazards downstream by temporarily detaining stormwater in the basin and slowly releasing it over an extended period of time. Such basins have been, and still are, effective in flood control. Currently, however, there is increased interest in controlling both the quantity *and* quality of stormwater runoff. Increased emphasis is being placed on so-called "dual-purpose" detention basins. These basins are designed to reduce downstream flooding and pollution, especially sediment pollution, by detaining water for a longer period of time than would be the case for single-purpose flood control detention basins. The longer detention time allows more sediment to settle out in the basin.

Detention basins are designed to reduce flood hazards downstream by temporarily detaining stormwater. Detention basins generally provide little wildlife habitat.

However, an inherent problem with detention basins functioning as pollution control structures is the potential for settled pollutants to become resuspended and washed from the basin with the next storm flow. Also, smaller basin outlet holes, required for longer detention time, tend to plug with trash and debris rapidly, and constitute a major maintenance problem.

Retention basins are designed to retain a permanent pool of water. They help reduce flood hazards downstream, improve the quality of water flowing through the basins, and may provide enhanced wetland wildlife habitat.

MAN-MADE WETLANDS FOR STORMWATER CONTROL AND WILDLIFE ENHANCEMENT

Permanent water impoundments are receiving increased attention as stormwater control facilities, particularly where pollution control and/or aesthetic values are important. Such impoundments, with surface discharge structures, are more efficient in settling out particulate matter than are detention basins. In addition, aquatic plants and animals often become established in these impoundments, thus offering potential for enhanced wetland wildlife habitat in many areas.

Permanent water impoundments are receiving increased attention as stormwater control facilities . . .

WATER QUALITY IMPROVEMENT

It is becoming clear that retention basins do a better job of improving the quality of water flowing through them than do detention basins. Perhaps of most importance is the fact that permanent water impoundments are more effective than detention basins in reducing sediment in the receiving body of water. Seventy-five percent or more of the sediment may be removed from water as it passes through a retention basin. Since other pollutants, like organic matter (measured by a B.O.D. test), phosphorus, and heavy metals are usually attached to sediment particles, these also are removed from the water as it passes through the impoundment. Studies show that most of the nitrogen, phosphorus, and heavy metals are thus stored in the sediment until taken up by roots for plant growth during the growing season. Water soluble forms of nitrogen and phosphorus serve as nutrients for algae, and "algal blooms" may be common in some waters. The chemicals are often released after plants die in the fall and winter when the effect on water quality is less. Thus, wetlands are often regarded as "valves" that hold back nitrogen and phosphorus during critical periods and release them during "safer periods."[10] This natural treatment process is not well understood, and researchers are continuing to learn more about it.

The U.S. Environmental Protection Agency, through its Nationwide Urban Runoff Program, is completing a national effort to evaluate water quality of stormwater draining from urban areas. Early results from a retention pond in Lansing, Michigan, indicate reductions of 75.0%, 66.7%, 58.3%, 30.8%, and 95.3% for suspended solids (sediment), B.O.D., phosphorus, nitrogen, and lead, respectively, in water passing through the pond.[2]

A University of Maryland researcher found very high (above 90%) removal of nitrogen; phosphorus; B.O.D.; and the heavy metals cadmium, iron, lead, and zinc for a small Montgomery County lake draining a large shopping mall, several apartment complexes, townhouses, a major highway, and several secondary roads.[11]

Studies in Winnipeg, Manitoba have shown that permanent impoundments (lakes with a minimum surface area of 5 acres) are the most optimum stormwater control measure for the city.[4] The impoundments control stormwater; reduce downstream pollution; and provide wildlife, recreational, and aesthetic values. At two facilities, Fort Richmond (with two impoundments) and Southdale (with eight interconnected impoundments), B.O.D. reductions of 30-75% and suspended solids (i.e., sediment) reductions of 85-94% were obtained.

Studies in Winnipeg, Manitoba have shown that permanent impoundments are the most optimum stormwater control measure for the city.

The lakes attract a variety of shorebirds in summer, and the Winnipeg researchers suggest allowing vegetation to develop on a portion of each impoundment for wildlife and aesthetics.

Because of environmental requirements to retain pollutants, the city of Tampa, Florida is changing from detention basins to retention ponds.[7] Attempts to use medium-sized detention basins for recreational purposes when the facilities were dry were not successful. The city now has 50 retention ponds and the permanent pools are valued aesthetically.

In addition to retention ponds, interest is growing in the use of marshes, both natural and man-made, and other wetlands, for water pollution control of urban runoff. Only a few documented studies have been reported, but consistent reductions of B.O.D. (54-89%), suspended solids (94-99%) and heavy metals (up to 97%) have been shown.[5] In one study, researchers found that a 7-acre marsh within a 70-acre watershed near the Twin Cities Metropolitan Area of Minnesota retained 77% of the total phosphorus and 94% of the total suspended solids entering the site during the study.[6] Perhaps artificially-created marshes would function in a similar manner.

WILDLIFE HABITAT ENHANCEMENT

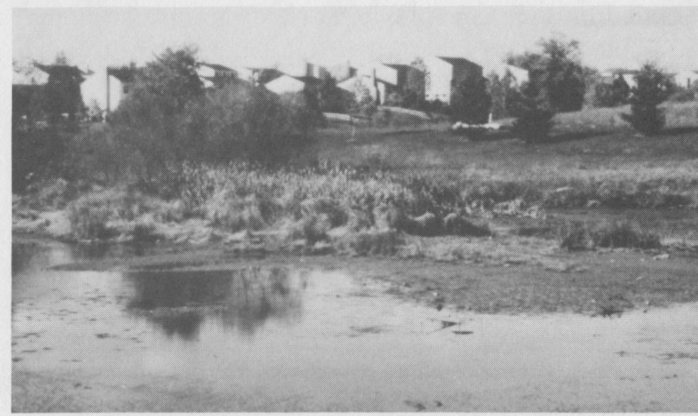
Though now widely used in transforming about a million acres of land to urban use each year in the United States, few stormwater control basins presently being built are designed with wildlife enhancement in mind. Also, little recognition is given to the value of wetlands created in the process of urbanization or urban redevelopment to mitigate losses of natural wetlands through drainage and filling. From past surveys and research, we know that of the Nation's wetlands, little more than one-half of the original acreage of approximately 127 million acres remain and, that acre for acre, they exceed all other habitat types in terms of wildlife productivity.

. . . few stormwater control basins presently being built are designed with wildlife enhancement in mind.

With this in mind, the National Institute for Urban Wildlife initiated research in 1982 to determine the extent of wildlife use of different types of stormwater control basins in Columbia, Maryland. The Institute investigated the design features of the various basin types which are particularly suitable for different kinds of wildlife, and also determined the attitudes of nearby residents toward different types of urban stormwater control basins and the wildlife associated with these facilities.

Results of the study showed that detention basins were used little by wildlife. These basins were frequently mowed and provided little wildlife cover.

Permanent water impoundments (lakes and ponds), on the other hand, provided habitat for waterfowl and other wetland birds, muskrats, and other wildlife. Common aquatic plants found in these impoundments included pondweeds, sedges, smartweeds, and cattails. Shallow water ponds with gently sloping sides had less open water and more aquatic vegetation (thus more food and cover for wildlife) than did deep, steep-sided ponds. In addition, most shallow ponds had sediment bars (soil deposited from upstream erosion)

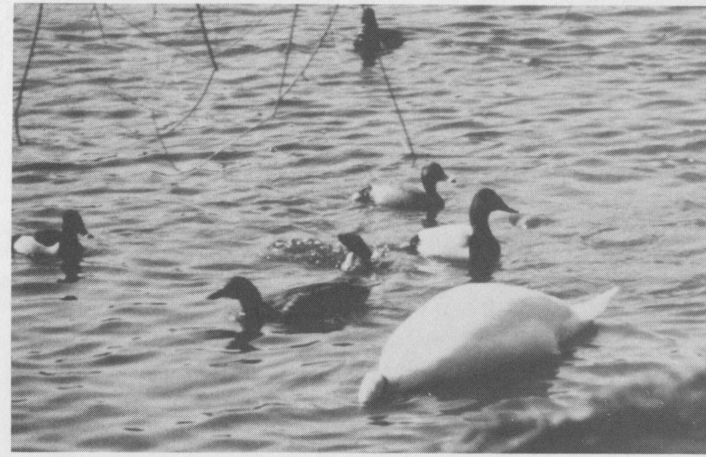


Shallow water ponds, with gently sloping sides, provide good wetland wildlife habitat. Soil deposited from upstream erosion often forms sediment bars above the water surface at stream inlets, resulting in excellent habitat. Aquatic vegetation provides food and cover for wildlife.

above the water surface at stream inlets, whereas few deep ponds had such bars. These sediment bars, and the shallow water surrounding them, provided attractive feeding and resting areas for waterfowl, marsh birds and shorebirds, and other wildlife.

Lakes provided the best habitat for migrating and wintering waterfowl and related species like grebes and coots. Seventeen species were recorded using the lakes during the spring migration of 1982. Other researchers have shown that most waterfowl species "flock up" or rest on larger bodies of water during the winter, but disperse to smaller impoundments during the breeding season.

Deep ponds, with steep side slopes, are less attractive to wildlife, but may provide recreational fishing opportunities.



Lakes in Columbia provide habitat for migrating waterfowl. This photograph, taken in March, 1982, shows a canvasback, a redhead, two ring-necked ducks, an introduced mute swan, and a hen mallard.

BUT WHAT ABOUT MOSQUITOES?

Six species of mosquitoes were recorded in the Columbia study, but data indicated that all ponds containing mosquitoes had large numbers of predaceous aquatic insects, acting as natural control agents, which kept mosquito populations in check. Predaceous aquatic insects that were recorded included mayflies, dragonflies, damselflies, water scorpions, diving beetles, backswimmers, water striders, giant water bugs, and water boatmen. Most impoundments also contained populations of sunfish which feed on mosquito larvae and pupae. These fish can help to control mosquitoes. The mosquito fish and fathead minnow also are recognized predators.

The most abundant mosquito in the Columbia, Maryland study, with the scientific name of *Culex territans*, does *not* attack man. The adults are seldom seen and *are believed to live entirely on cold-blooded animals.* They have been observed feeding on frogs by several investigators. So, just as there are many species of birds—few of which cause damage or nuisance problems—so are there numerous species of mosquitoes, and not all mosquitoes cause problems.

URBAN WETLANDS AND PEOPLE

An investigator in 1973 pointed out the need to define general public attitudes toward suburban runoff and water resources.[3] He stated: "The success of any program to manage runoff as a water resource in the suburban environment is highly dependent upon the support of the people in that environment. Such a program may be technically feasible, may make sense from a resource management perspective, and may have the full support of all the 'experts', but will still fall short of implementation if the people do not accept the program." Likewise, wildlife management programs, particularly in urban areas, should reflect the needs and desires of people living in the area.

"The success of any program to manage runoff as a water resource in the suburban environment is highly dependent upon the support of the people in that environment."

To determine peoples' attitudes toward different types of urban stormwater control basins and the wildlife resource associated with these facilities in Columbia, the National Institute for Urban Wildlife surveyed over 600 homeowners in the city.[1] The majority of residents (98%) said they enjoy viewing birds and other wildlife that make use of the city's impoundments, and 92% considered the sight of ducks to outweigh any nuisances the ducks create. Columbia homeowners clearly preferred retention ponds (75%) to dry detention basins (17%), and agreed (94%) that it would be desirable to design and manage future stormwater control basins for fish and wildlife as well as for flood and sediment control if this were feasible from technical and economic standpoints. In response to the question, "Do you think wetlands add to the beauty, diversity, and quality of the human living environment?", 94% answered positively. Perhaps most importantly, 75% of respondents felt that permanent bodies of water added to real estate values and 73% said that they would pay more for property located in a neighborhood with stormwater control basins designed to enhance fish or wildlife use. Many residents were involved in recreational activities near the impoundments, including walking, biking, bird watching, boating, and general nature enjoyment. In the sense that permanent water impoundments add diversity to the lives of urban residents, they may be said to create "habitat for people" as well as for wildlife.

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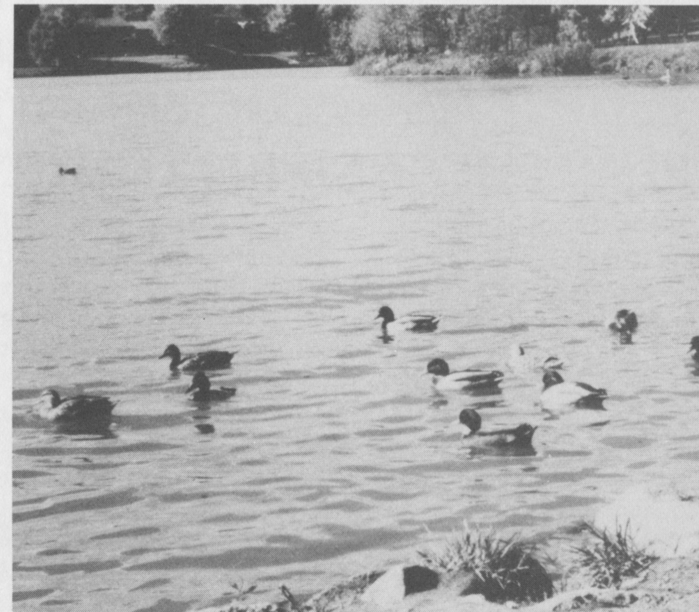

A survey in Columbia, Maryland, revealed that residents enjoy viewing birds and other wildlife that make use of the city's impoundments.

SUMMARY AND RECOMMENDATIONS

Detention and retention basins are widely used to control stormwater runoff in urban areas. Detention basins are designed to detain water temporarily and release it slowly to a receiving body of water. They are usually dry or muddy between storms. Retention basins, on the other hand, are designed to retain a permanent water pool. Both help control floods, but retention basins are superior for improving water quality of urban runoff. Permanent water impoundments also offer enhanced aesthetic, wildlife, and recreational values. Even so, few stormwater control basins currently being built are designed with wildlife enhancement in mind.

Research conducted by the National Institute for Urban Wildlife in Columbia, Maryland, in 1982, showed that wildlife responded quite differently to various types of stormwater control structures, and that local residents were very much interested in wildlife. Permanent water impoundments received the most wildlife use and were preferred over dry detention basins by residents in Columbia. To optimize the value of urban stormwater control impoundments for wildlife, the Institute recommends the following planning and design guidelines be considered:

- Where possible, impoundments for stormwater control should aim to retain water rather than merely detain it.
- Pond design must meet applicable stormwater control criteria, including legal requirements.
- Natural resources personnel, including biologists, should be consulted during the planning and design stages.
- All potential pond locations should be evaluated to select the most suitable site in relation to the developed area and surroundings, and in recognition of physical, social, economic, and biologic factors.
- There should be an adequate drainage area to provide a dependable source of water for the intended year-round use of the pond, considering seepage and evaporation losses.
- The soil on site must have sufficient bearing strength to support the dam without excessive consolidation and be impermeable enough to hold water.
- The pond site should be located in an area where disturbances to valuable existing wildlife habitat by construction activities will be avoided or minimized.
- For maximum wetland wildlife value, water depth should be from 15 to 24 inches for 25 to 50% of the water surface area with about 50 to 75% having a depth of approximately 3½ to 4 feet. A greater depth may be advisable for more northern areas subject to greater ice depths. A side slope of 10:1 or less is preferable to steep slopes for wildlife use. Shallow ponds in our study (average water depth 2.3 feet with average side slopes of 16:1) were superior to deep ponds (average water depth 6.8 feet with average side slopes of 3:1) with respect to wildlife use. Also they are safer for children who might wade or fall into the ponds.
- Ponds should be designed with the capability to regulate water levels, including complete pond drainage, and with facilities for easy cleaning, if necessary.
- For larger ponds (those approximately 5 acres or greater), one or more small islands are recommended. The tops of the islands should be graded to provide good drainage. Appropriate vegetative cover should be established to prevent erosion and provide bird nesting cover.

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The mission of the National Institute for Urban Wildlife is to be a responsible and effective scientific and educational organization advocating the enhancement of urban wildlife values and habitat, and the wise use of all natural resources for the benefit of people in cities, suburbs, and developing areas.

The Institute accomplishes its mission by: (1) conducting sound research on the relationships between man and wildlife under urban and urbanizing conditions; (2) discovering and disseminating practical procedures for maintaining and enhancing wildlife populations, and controlling certain wildlife species in urban areas; (3) building an appreciation for, and an understanding of, wildlife and wildlife needs; (4) establishing a positive conservation ethic through education programs directed at the community and neighborhood levels; and (5) illustrating how all segments of our people have a vested interest in wildlife and the environment we mutually share.