MITIGATION OF URBAN RUNOFF IMPACTS ON ATLANTA STREAMS

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Abstract. An interdisciplinary scientific panel was convened to assess the condition of Atlanta's streams and to identify those watershed management actions with the greatest potential to improve water quality and riparian and stream habitat in the Atlanta region. Broad recommendations included a description of elements to incorporate into a watershed management program for Atlanta, and specific suggestions for demonstration projects in four small, headwater watersheds. The four chosen demonstration sub-watersheds collectively reflect the gradient of impervious cover and stream quality present in Atlanta, and individually represent conditions commonly observed throughout the area. Therefore, the general recommendations for these demonstration areas should be broadly applicable to the rest of the region.

INTRODUCTION

Greater Atlanta's rapid growth has been associated with widespread degradation of local terrestrial and aquatic habitats and water quality (Georgia Dept. of Natural Resources 1996; CH2MHill 1998). Development of the sloping landscape and highly erodible soils of the Atlanta Piedmont geologic region has resulted in the discharge of significantly increased rates and volumes of surface rainfall-runoff and pollutant loads to local water bodies. Local impacts associated with this urban runoff include: increased erosion and sediment deposition; increased summer stream water temperatures; physical degradation of stream channels and riparian buffer zones; loss of in-stream biota, fisheries, and wildlife; violations of human health and ecological water quality standards; decreased aesthetics from litter, turbidity, and odor; flooding; impairments of downstream uses, including for drinking water, navigation, and recreation; and economic losses (Georgia Dept. of Natural Resources 1996; Center for Watershed Protection 1998; Devivo *et al.* 1997; University of Georgia 1997a and 1997b).

In December of 1997, the International Life Sciences Institute's (ILSI) Risk Science Institute (RSI) convened a working group (the authors of this paper) with expertise in urban runoff assessment and mitigation, and stream restoration. The group was asked to assess the condition of Atlanta's streams and identify those watershed restoration actions that have the greatest potential to improve riparian and in-stream habitat and water quality in the Atlanta region. Recommendations included both broad suggestions for implementing a watershed management program in Atlanta, and specific suggestions for demonstration projects in four small, headwater watersheds (ILSI 1998).

BASIC ELEMENTS OF A WATERSHED MANAGEMENT PROGRAM FOR ATLANTA

The working group recommended that prior to the implementation of specific watershed restoration techniques and to ensure long-term plan effectiveness, several basic elements of a watershed management program should be adopted in the region. Although many of the following elements may exist under various programs in the region, the widespread severity of degraded streams in the greater Atlanta region indicates the need to further develop, unify, and implement these elements under a pro-active, comprehensive watershed program for Atlanta. These elements include:

-Create an Institutional Framework for Watershed Management

-Develop a Comprehensive Storm and Surface Water Control Program with Dedicated, Stable Funding
-Enhance and Enforce Sediment and Erosion Control Programs
-Design Detention Ponds for Protection of Downstream Water Quality and Channel Protection
-Preserve and Expand Tree Canopy
-Improve Management of Buffers and Sensitive Areas
-Improve Management of Flood Plains
-Enhance Land Development Provisions
-Investigate Daylighting (or unearthing) of Streams
-Promote Utility Relocation Away From Streams
-Control Invasive and Exotic Species
-Enhance Public Education and Outreach

URBAN STREAM RESTORATION STRATEGIES

The preservation and restoration of *watershed functionality* should be a key objective for watershed programs. The loss of vegetation, compaction and erosion of soil, introduction of impermeable surfaces, altered hydrology/drainage patterns, and physical modification of stream channels that accompanies urbanization heavily impacts the natural functions of the watershed such that water and pollutants are transported as surface runoff quickly downstream, causing a variety of well-documented physical, chemical, and biological impacts in receiving waters. Watershed functionality is lost incrementally as land is developed and must be regained incrementally. Opportunistically it is regained through a variety of actions ranging from stormwater management by homeowners to implementation of full scale watershed management plans. Actions that reduce surface runoff by promoting infiltration and groundwater recharge are particularly important for re-establishing watershed functionality (Ferguson 1998).

Several restoration strategies should be applied together to help restore the functionality of urban watersheds and streams. These strategies are intended to compensate for stream functions and processes that have been diminished or degraded by prior watershed urbanization.

1. Partially restore the pre-development hydrological regime.

The primary objective is to reduce the frequency of bankfull and sub-bankfull floods in the contributing watershed. This is often accomplished by reducing impervious cover, promoting infiltration, and by constructing upstream stormwater retrofit ponds that capture and detain increased stormwater runoff for up to 24 hours before release (i.e., extended detention).

2. Reduce urban pollutant pulses.

Generally, three approaches can be applied to reduce pollutant inputs to an urban stream: watershed pollution prevention programs, the elimination of illicit or illegal sanitary connections to the storm sewer networks, and stormwater retrofit ponds or wetlands.

3. Stabilize channel morphology.

Depending on the stream order, watershed impervious cover, and the height and angle of eroded banks, a series of different methods can be applied to stabilize the channel, prevent further erosion, and enhance habitat. These include imbricated riprap, and soil bioengineering methods. The installation of woody and herbaceous vegetation such as willow, buttonbush, and dogwood in the form of soil bioengineering methods will provide multiple benefits in the restoration process and improve functionality of degraded aquatic and riparian ecosystems (Sotir and GSSWC 1994).

4. Re-establish riparian cover.

Reestablishing the predevelopment riparian cover plant community along the stream network can entail active reforestation of native species, removal of exotic species, or changes in mowing operations to allow gradual succession. It is often essential that the riparian corridor be further protected by a wide vegetated stream buffer.

5. Restore in-stream habitat structure.

Key restoration elements include the creation of pools and riffles, confinement and deepening of the low flow channels, and the provision of greater structural complexity across the stream bed. Typical strategies include the installation of log checkdams, stone wing deflectors and boulder clusters along the stream channel.

6. Protect critical stream substrates.

The beds of urban streams are often highly unstable and clogged by fine sediment deposits. The energy of urban stormwater can often be used to create cleaner substrates—through the use of methods such as double wing deflectors and flow concentrators. If thick deposits of sediment have accumulated on the bed, mechanical sediment removal may be needed.

7. Recolonization of the stream community.

Physical barriers such as culverts and dams can hinder recolonization of otherwise restored stream reaches. The stream must be examined to determine if barriers exist, whether they can be removed, or whether selective stocking of native fish and invertebrates are needed to recolonize the stream reach.

APPLICATION OF WATERSHED PRINCIPLES TO FOUR SELECTED SUB-WATERSHEDS

The working group examined four sub-watersheds in the Atlanta region and craft demonstration projects for each that encompass a combination of the most promising watershed restoration activities. The four chosen demonstration sub-watersheds collectively reflect the gradient of impervious cover and stream quality present in Atlanta, and individually represent conditions commonly observed throughout the area. Therefore, the recommendations for these demonstration areas should be broadly applicable to the rest of the region. The four chosen demonstration areas included two highly urbanized areas (Nancy Creek and North Utoy Creek), one moderately urbanized area that contained significant open space (Lullwater Creek), and one relatively undeveloped area (Fernbank Brook). The choice of these areas does not imply that there are not other equal or more suitable sites on which to develop demonstration projects in Atlanta. Note that to focus solely on urban runoff, the chosen sub-watersheds do not have ongoing combined sewer overflows (CSO).

For each of the four demonstration areas, the panel incorporated the seven restoration strategies above into two broad sets of recommendations: opportunities to control runoff from the watershed and opportunities for in-stream, flood plain, and riparian zone restoration. Each watershed was examined to determine where these strategies could opportunistically be applied. It must be stressed that what follows are only conceptual designs, and additional local stakeholder input and feasibility studies are needed to flesh out design details. Also, these limited demonstration projects have little chance of long-term success without implementation of the basic watershed management program recommendations noted earlier.

Unnamed Fork of Nancy Creek in Chamblee.

This small, headwater stream in northwest Atlanta is surrounded by a highly impervious (59%) watershed of 1079 acres that is dominated by residential, commercial, and industrial land uses (CH2MHILL 1998). The forested riparian buffer is fragmented and has been invaded by exotic species such as English Ivy and privet. Excessive runoff from the surrounding impervious landscape has resulted in the stream channel being deeply incised, with highly unstable, almost vertical banks. Stream habitat is poor, and aquatic health is impaired. Unfortunately, opportunities to control runoff in this heavily developed region by conventional means such as the installation of large stormwater control facilities seem very limited. However, the working group recommended a demonstration project that included the use of porous pavements and possibly infiltration trenches on and around portions of the industrial and commercial sites to treat runoff, stakeholder education emphasizing pollution and on-site stormwater management, improvements to the riparian corridor, and streambank stabilization (ILSI 1998). These actions should decrease downstream pollutant loads, prevent further degradation, increase aesthetics, and increase watershed functionality.

North Utoy Creek at John A. White Park.

The 2200 acres above John A. White Park is greater than 50% impervious, and dominated by single family residences, and commercial, industrial, transportation, and higher density residential uses. This park contains two concrete channels that received 446 million gallons per year of CSO (CH2MHILL 1998). However, as of March 1998, sewer separation activities removed the CSO discharges, and these channels now only receive stream flow and urban runoff. This watershed presents a unique opportunity for a demonstration project that focuses on stream dechannelization and restoration within a public park. Other components of this demonstration project include daylighting of stream segments, restoration of vegetated streambanks and riparian zones, relocation of above ground utility stream crossings that may constrict stream flow, and public education.

Lullwater Fork of Peavine Creek.

This small tributary has a drainage area of 1032 acres of which 34% is considered impervious (CH2MHILL 1998). Major land uses include residences, golf courses, parks, and limited commercial and industrial developments. A fragmented forested riparian buffer covers approximately two-thirds of its length, but the aquatic health of the stream is poor. Significant lengths of the stream are either piped underground or in above-ground concrete channels; other stream sections contain banks that are heavily incised, undercut, and actively widening. This watershed has the greatest potential for significant improvements in stream quality via implementation of a full range of watershed and in-stream restoration activities, including: installation of stormwater detention ponds, improved management of golf course runoff, education of landowners to manage stormwater on their own properties, daylighting of buried streams, dechannelization of up to 4,000 feet of concrete stream channel, and restoration of stream, bank, and forested riparian zone habitats.

Fernbank Brook at Fernbank Forest

Fernbank Brook is an example of a rare, high quality reference stream that contains remnant habitats and populations of native terrestrial and aquatic species. Out of a total of 77 acres in this watershed, 65 acres are in Fernbank Forest, a protected urban forested preserve (Walker 1996). The quality of its terrestrial and aquatic habitats and communities is excellent. Unfortunately, as evidenced by several examples of severe erosion near its headwater springs, it is also extremely sensitive to the impacts of even modest increases in urban runoff. The highly erosive soils and steep slopes in this area highlight the need for an advanced level of understanding and protection.

Several measures are required to protect this unique resource, including: obtaining conservation easements for private lands bordering the preserve, especially targeting sensitive areas such as steep slopes and wetlands; pursuing voluntary land acquisition as opportunities arise; homeowner education on methods to control runoff on their properties, including on-site infiltration techniques; installation of check dams along the incised headwater streams; the dredging of a local pond to enhance its ability to capture silt and sediment; and the removal of invasive terrestrial plants.

CONCLUSIONS

Prior to the implementation of specific watershed restoration techniques and to ensure long-term plan effectiveness, several basic elements of a watershed management program should be adopted in the region. The focus of this basic program for Atlanta is the prevention of watershed problems, rather than reactions to them. Opportunities to restore watershed functionality incrementally should be pursued and identified by a detailed inventory, assessment, and master planning for each area. The recommendations above should be viewed as a starting point for the development of sub-basin watershed management plans and the design of more detailed demonstration projects.

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