

**COMMUNITY RESPONSES TO RUNOFF POLLUTION:
FINDING FROM CASE STUDIES ON STORMWATER POLLUTION CONTROL**

George P. Aponte Clarke

Policy Analyst, Natural Resources Defense Council
40 West 20' Street, New York, New York 100 11

Peter H. Lehner

Chief, Environmental Protection Bureau, New York State Attorney General's Office
120 Broadway, 261 Floor, New York, New York 10271
(formerly Senior Attorney and Clean Water Project Director,
Natural Resources Defense Council)

Diane M Cameron

President, Cameron Associates
3102 Edgewood Road, Kensington, Maryland 20895
(formerly Senior Scientist, Natural Resources Defense Council).

Andrew G. Frank

Litigation Associate, Paul, Weiss, Rifkind, Wharton, and Garrison
1285 Avenue of the Americas, New York, New York 100 19
(formerly Policy Analyst, Natural Resources Defense Council).

ABSTRACT

Urban stormwater runoff poses a serious threat to the nation's water resources. Concerns about urban runoff and interest in proposed new federal stormwater regulations prompted documentation of existing effective stormwater strategies. The purpose of this documentation is to encourage municipal action and help empower communities to address this critical issue. To achieve this goal, more than 150 examples of effective strategies from across the nation were evaluated and compiled. The case studies highlight effective pollution prevention, administrative, and financing measures for addressing stormwater runoff. They show on a practical level that stormwater management can be environmentally effective, economically advantageous, and politically feasible. In Addition, they offer an outline for further successful stormwater management strategies. Elements critical to the effectiveness of these programs include: a pollution prevention emphasis with structural treatment measures when needed; a focus on preserving natural features and processes; a framework that creates and maintains accountability; a dedicated and equitable funding source to ensure long-term viability; strong leadership; and effective administration. These broad themes translate into a set of nine local actions for addressing the technical, social, and political issues associated with stormwater runoff. Following these actions will help communities form a sound stormwater policy.

KEY TERMS: urban stormwater runoff; impervious surfaces; pollution prevention; best management practices; diffuse pollution; accountability.

INTRODUCTION

Pollution from all diffuse sources, including urban stormwater pollution, is considered to be the most important source of contamination in the nation's waters (U.S. Environmental Protection Agency, 1997a). Specifically, urban and suburban runoff is the second most prevalent source of water quality impairment in the nation's estuaries after industrial discharges, and the fourth most prevalent source of impairment in lakes after agriculture, unspecified nonpoint sources, and atmospheric deposition of pollutants (U.S. Environmental Protection Agency, 1998b). Uncontrolled urban runoff also contributes to hydrologic and habitat modification, two important sources of river impairment identified by the U.S. Environmental Protection Agency (EPA).

The polluted stormwater runoff problem has two main components: the increased volume and rate of runoff from impervious surfaces and the concentration of pollutants in the runoff. Both components are closely related to development in urban and urbanizing areas (Booth and Reinelt, 1993; Schueler, 1994; U.S. Environmental Protection Agency, 1997b). When impervious cover (roads, highways, parking lots, and roof tops) reaches between 10 and 20 percent of the area of a watershed, ecological stress becomes clearly apparent (Klein, 1979; Booth and Reinelt, 1993; Schueler, 1994). Everyday activities can deposit on these surfaces a coating of various harmful materials. When it rains or when snows melts, many of these pollutants are washed into receiving waters, often without any treatment.

The deposition of pollutants and the increased velocity and volume of runoff together, cause dramatic changes in hydrology and water quality (Klein, 1979; Jones and Clark, 1987; Booth, 1990; Galli, 1990; US Environmental Protection Agency, 1997b). These changes affect ecosystem functions, biological diversity, public health, recreation, economic activity, and general community well-being (Bannerman *et al.*, 1993; Novotny and Olem, 1994; Haile *et al.*, 1996; Carpenter *et al.*, 1998). Urban stormwater is not alone in polluting the nation's waters. Industrial and agricultural runoff are often equal or greater contributors. But the environmental, aesthetic, and public health impacts of diffuse pollution will not be eliminated until urban stormwater pollution is controlled.

Currently, there is substantial concern about the impacts of urban and suburban runoff. Stormwater runoff pollution is an important issue since most of the population of the United States lives in urban and coastal areas. Water resources in urban and coastal areas are highly vulnerable to and are often severely degraded by stormwater runoff. Economic impacts are another important aspect of this concern. Even a partial accounting shows that hundreds of millions of dollars are lost each year through added government expenditures, illness, or loss in economic output due to urban runoff pollution and damages (U.S. Environmental Protection Agency, 1998a). The ecological damage is also severe and is at least as significant.

)While urban and suburban runoff continues to be a critical issue, there is substantial evidence that the problems are not intractable. Increasingly, communities are recognizing the causes and consequences of uncontrolled urban runoff and taking action to control and prevent runoff pollution,

often without any mandate. These innovative communities are realizing the environmental, economic, and social benefits of preventing stormwater pollution. However, neither the extent of these efforts nor the specific actions being taken have been well documented.

There is also a growing interest in proposed new federal stormwater regulations. Comprehensive stormwater regulation is required under Section 402(p) of the Clean Water Act. Since 1992, cities with populations over 100,000, certain industries, and construction sites over 5 acres have been required to develop and implement stormwater plans under Phase I of the National Pollutant Discharge Elimination System (NPDES) stormwater regulations (U.S. Environmental Protection Agency, 1990). In October 1999, EPA is expected to promulgate a new rule requiring municipalities with populations fewer than 100,000 people located in "urbanized areas" (where population density is greater than 1,000 persons per square mile) to develop stormwater plans. Under what is known as the "Phase II" rule, the EPA and states will develop "tool boxes" from which the smaller local governments can choose particular stormwater strategies to develop their stormwater plans (U.S. Environmental Protection Agency, 1998a).

To address these issues and concerns, we developed a study to examine, document, and disseminate information on successful stormwater pollution prevention efforts. The primary goal of this study was to document environmentally effective and economically advantageous stormwater pollution prevention strategies. The study resulted in a report, *Stormwater Strategies: Community Responses to Runoff Pollution*, that highlights some of the most effective existing stormwater strategies from around the country (Lehner *et al.*, 1999). The report provides substantial evidence that such programs exist and highlights a variety of innovative strategies actually being used. The report also aims to provide guidance to communities addressing stormwater issues, encourage municipal action, and help empower communities to be involved in this critical issue. This paper summarizes the study and presents its primary findings and recommendations.

STUDY DESIGN AND OBJECTIVES

The study was exploratory in nature, with the intent of presenting information on existing effective stormwater management programs. To achieve this goal, we collected cases of environmentally beneficial and cost-effective stormwater programs from across the country. We compiled this information into the case-study-based report described above. This information and report is now the basis for a comprehensive outreach effort.

The first step was to gather information on programs and projects by examining existing programs (several now under Phase I requirements as well as many that started earlier), reviewing literature, contacting regional and local stormwater management experts and researchers, and interviewing representatives from stormwater management or other local government agencies. We gathered information on over 250 programs. The information was then examined in detail and narrowed down to a set of case studies that demonstrated some element of success. Three fundamental criteria for selection were used: environmental gains, economic advantages, and community benefits. Environmental gains included biological, hydrological, or chemical improvements resulting from stormwater management. Economic advantages included cost savings

to the municipality or developer, or increases in property values related to the pollution prevention measure. Community benefits included aesthetic or recreational enhancement, administrative or institutional successes, or community relations improvements.

Seventy-seven programs and projects were selected as case studies for the final report. Another 88 programs were annotated to provide additional references that were not fully evaluated for the report. The case studies represent communities of all sizes, types, and regions throughout the United States. To help ensure accuracy, local experts or people familiar with the program, called "groundtruthers," were contacted to review the case studies and add information from their own knowledge and experience.

The case studies were first organized geographically by dividing the United States into six regions based in part on general rainfall patterns. Within each of the regions, case studies were then further subdivided into the following five categories of stormwater management measures: addressing stormwater in new development and redevelopment; promoting public education and participation; controlling construction site runoff; detecting and eliminating improper or illegal connections and discharges; and implementing pollution prevention for municipal operations. These categories roughly parallel those measures that large municipalities currently address under Federal regulations (40 CFR parts 122.26 and 123.25) and small municipalities will address under pending Federal regulations (U.S. Environmental Protection Agency, 1998a).

Findings

Through over 150 examples of actual programs, this report provides substantial evidence that stormwater pollution can be prevented with proper planning and implementation in growing or redeveloping areas. The examples presented in the report also demonstrate that if the communities highlighted can measurably and cost-effectively reduce stormwater pollution, so can other communities and states.

Stormwater Management Measures

Individually, the case studies provide detailed examples of substantial water quality improvement, effective or innovative stormwater control strategies to protect the natural environment, significant cost-savings, and important ancillary benefits to the community. The programs and strategies highlighted come from communities of all sizes, types, and regions. They include efforts by municipal agencies, developers, and community groups. In many cases, several of these groups worked together to create win-win outcomes. The case studies highlight a variety of strategies for addressing runoff in new development and redevelopment, promoting public education and participation, controlling construction site runoff, detecting and eliminating improper or illegal connections and discharges, and implementing pollution prevention for municipal operations. -

Addressing Stormwater in New Development and Redevelopment. By far the most important category of stormwater strategies focuses on land use and development. It encompasses a wide range of measures including regional or watershed planning, buffers and open space preservation, infill

development, conservation design, and the use of site-specific structural and nonstructural treatment measures. One of the best strategies a municipality or developer can employ is to minimize the aggregate amount of new impervious surfaces, since where impervious surface does increase, treatment or control of runoff is needed. The case studies demonstrate that minimizing impervious surfaces, within desired growth targets, can be a highly effective and beneficial strategy. For example, the Magdalene Reserve development in Hillsborough County, Florida was able to reduce impervious cover and prevent runoff pollution while saving money. The developer did so by eliminating 25 percent of roadway, preserving existing trees and ground cover, reducing lot grading, installing swales and retention ponds to control runoff, using alternative landscaping techniques to reduce runoff pollution, and preserving 45 percent of the site as common open space. In addition, the more attractive houses sold better than conventional subdivisions (see Lehner *et al.*, 1999, p. 120).

Promoting Public Education and Participation. Individuals play a key role in reducing stormwater impacts both in their own day-to-day activities and in showing support for municipal programs and ordinances. Effective public education, outreach, and participation programs are essential for involving citizens in pollution prevention activities, volunteer monitoring and inspection efforts, and the political and planning processes. The most successful programs highlighted accomplished three goals: they educated the public about the nature of the problem, they informed the people about what they can do to solve the problem, and they involved citizens in hands-on activities to achieve pollutant reduction or restoration targets. One example of this success is the University of Florida Cooperative Extension Service's programs that target landscape management. By teaching homeowners and professionals about the consequences of landscaping decisions and how to minimize environmental impacts by using sound practices, the extension service efforts have dramatically effected chemical use in 47 Florida counties (see Lehner *et al.*, 1999, p. 129).

Controlling Construction Site Runoff. The case studies demonstrate that effective construction site pollution prevention is politically and economically feasible and can dramatically reduce pollution. In addition, these measures can have benefits for the developer as well: control measures such as phasing, mulching, and revegetation not only reduce erosion, but also have proven repeatedly to increase the value of the property (Herzog *et al.*, 1998). While existing programs rely on a fairly wide variety of erosion and sediment control practices, virtually all successful strategies require proper planning and phasing of construction activities to avoid disturbing more land than necessary during construction. The case studies demonstrate that the most effective programs rest on four cornerstones laid in pairs: enforcement and education; erosion prevention and sediment control. However, the first and over-arching necessity is a clear set of requirements. Chattanooga, Tennessee achieved greater compliance b% taking this approach. The city developed a program with well defined erosion control requirements, a contractor education and certification program, and an aggressive inspection effort with stiff fines for noncompliance. Chattanooga's Erosion Control School has certified over 185 developers to date (see Lehner *et al.*, 1999, p. 135).

Detecting and Eliminating Improper orfllegal Connections and Discharges. Local governments have found that identifying and eliminating illicit connections and discharges is a remarkably simple and cost-effective way to eliminate some of the worst pollution from stormwater and to improve

water quality. The case studies demonstrate that two factors are critical to success of this element of stormwater programs: tracking or finding illicit connections and discharges and enforcement. To find illegal discharges and illicit connections, the most successful programs use a range of techniques. Enforcement, however, is often the key to success. In Cohasset, Massachusetts, for example, enforcement orders mandating that private owners fix their septic systems resulted in the reopening of over 400 acres of shellfish beds. Citizens can also play an important role. In Alabama, the Alabama Water Watch Association and the Birmingham Stormwater Management Agency forged a partnership to train volunteers to help identify and detect illicit discharges by monitoring the city's 158 critical screening sites and outfalls.

Implementing Pollution Prevention for Municipal Operations. A wide range of municipal operations can affect stormwater quantity and quality. The case studies reveal that some local governments have been able to manage their municipal operations to make a significant positive contribution to reducing stormwater pollution. The municipalities highlighted have done so in a variety of ways including reducing the use of harmful chemicals in the maintenance of municipal properties and vehicles, improving the maintenance and cleaning of roads and stormwater infrastructure, and training staff in pollution prevention practices. Several municipalities have taken these steps at their golf courses. For example, the Legacy golf course in Springfield, Tennessee is preventing runoff pollution by taking the following actions: maintaining an uncultivated natural buffer and 25-foot no-spray zone around all waterbodies; designing water hazards as stormwater retention ponds; and practicing integrated pest management (IPM). The course currently uses 75 percent organic or slow-release fertilizers and has significantly reduced the use of chemical pesticides. In addition to protecting the environment, the turf management approaches used at the Legacy have saved the course money (see Lehner *et al.*, 1999, p. 142).

The Foundation of Success

Collectively, the case studies present a clear model for success. Evaluation of the case studies revealed several common elements among the highlighted programs. We distilled these elements into the broad themes listed below to help guide communities as they develop or improve stormwater programs. Since they are based on actual programs, these themes form a solid foundation for successful programs.

Preventing pollution is highly effective and saves money. There are a range of measures known as "pollution prevention" that dramatically and cost-effectively reduce the quantity and concentration of pollutants winding up in stormwater. Common pollution prevention measures include reducing or eliminating the use of products with harmful chemicals, preventing erosion at construction sites, reducing the amount of pavement in new developments, and changing maintenance practices at home and in businesses or municipal operations. In highly urbanized areas, however, such measures may not be possible. In such cases, several communities have found treatment of runoff with structural measures or retrofitting existing structures to be effective alternatives.

Preserving and utilizing natural features and processes have many benefits. Many communities and developers have found strategies that rely on natural processes to be highly effective and efficient. Undeveloped landscapes absorb large quantities of rainfall and snowmelt; vegetation helps

to filter out pollutants from stormwater. These communities have benefited from implementing environmentally friendly alternative site design or "greeninfrastructure" by saving money and optimizing open space. Buffer zones, conservation-designed development, sensitive area protection, or encouragement of infill development all try to enhance natural processes and are among the most effective stormwater programs highlighted.

Educating and informing the general public and municipal staff improves program effectiveness. Providing information and training to the general public and local businesses is a key component to many of the highlighted programs. Public participation and education form a link between local governments and their citizens. Education programs encouraging citizens to change their habits and to contribute to cooperative efforts often form an early element of stormwater programs. Since many sources of stormwater pollution are derived from individual activities such as driving and maintaining homes, educating the public goes a long way to reducing stormwater pollution. Several communities involve the public in civic activities such as monitoring water quality or stenciling storm drains, which not only provide educational opportunities but also save the municipality money.

Strong incentives, routine monitoring, and consistent enforcement establish accountability. Enforcement, or more broadly accountability, is a key element to improving water quality. All actors need a clear statement of performance goals, and they need to be held accountable by all the others for accomplishing these goals. We found that programs with high accountability were the most effective, often achieving pollutant reductions of 50 percent or greater.

Establishing a dedicated source of funding builds strong support. Effective stormwater programs are financially viable and affordable. A stable funding source is critical to program success and community support. Stormwater fees have proven effective and popular for paying for necessary measures without political or community resistance. Nearly 200 communities across the nation are already realizing the benefits of implementing stormwater utilities as dedicated and equitable funding sources.

Strong leadership is often a catalyst for success. Success, at least at first, often requires an individual to champion the project and make it happen.

Effective administration is critical. Regardless of which strategies a community chooses, those programs with clear goals and objectives were the most successful. Such clarity enhances accountability, responsibility, and trust. Furthermore, an established and understood institutional framework often improves administration by fostering collaboration among different parts and levels of government, neighboring communities, and local citizens. Effective administration allows implementation of broad-based, multi-faceted programs, which are often the most effective at controlling the diffuse problem of stormwater pollution.

DISCUSSION: RECOMMENDATIONS FOR LOCAL ACTION

To further guide communities addressing stormwater runoff issues, we translated the broad themes presented above into an action plan based on nine key recommendations. These actions roughly parallel the broad themes presented above. The case studies demonstrated that following the

nine local actions outlined below will help build a strong framework for effective, efficient, and successful Stormwater management over the long term.

Plan in advance and set clear goals. Carefully plan programs as opposed to simply reacting to provided opportunities, crises, or transient pressures. Planning allows development of more effective and cost-effective actions. An essential outcome of planning; is to address the issues and concerns of all stakeholders involved. Planning does not require large staffs or extensive technology.

Encourage and facilitate broad participation. Planning and program development processes should involve multiple levels of government, key members community, and professionals from a variety of related disciplines. Include and encourage planning, education, public participation, regulation, monitoring, and enforcement in Stormwater programs. Key to this outcome is the public's understanding of the issue, how it relates to them, and what they can do about it. Look for public-public and private-public collaboration opportunities.

Promote public education opportunities. Implement broad-based programs that reach a range of audiences and solicit different levels of public involvement. Remain committed to the education program and take advantage of existing community organizations to enhance participation. Educating and informing the public not only helps to reduce pollution, it also builds support for municipal Stormwater programs.

Work to prevent pollution first; rely on structural treatment only when necessary. Focus on prevention-based approaches, through regional and watershed planning, local zoning ordinances, preservation of natural areas, Stormwater-sensitive site design, widespread compliance with dumping and connection prohibitions, erosion prevention, and broad-based education as these are significantly more effective than treatment of polluted runoff.

Establish and maintain accountability. Essential components of this process are setting clear standards, creating strong incentives and disincentives, conducting routine monitoring and inspections, keeping the public informed, promoting public availability of Stormwater plans and permits, and consistently enforcing laws and regulations. Consider and encourage innovative strategies and approaches. Strong enforcement is often key to significant water quality improvements.

Create a dedicated funding source. Dedicated funding sources, such as Stormwater utilities or dedicated environmental fees, help ensure that Stormwater programs are stable over time and help gain public support. Also consider budget-saving measures such as creative staffing, public-public and public-private collaboration, and building off existing programs.

Tailor strategies to the region and setting. Recognizing that every case will be different, consider strategies that are particularly tailored to the region, the specific audience, and the problem.

- *Evaluate and allow for evolution of programs.* Set clear goals and priorities, and allow programs to develop over time. Establish clear ways to check and see that goals and objectives are being met. This opens opportunities for improvement and helps ensure long-term success.
- *Recognize the importance of associated community benefits.* Stormwater pollution measures usually offer ancillary quality-of-life benefits in addition to targeted improvements. For example, preserved areas offer parks, ponds offer beauty and habitat, clean streets are more attractive, education helps empower people, and sediment control improves fisheries and prevents flooding.

CONCLUSION

Many fine handbooks provide theoretical and technical guidance concerning the design and implementation of effective stormwater pollution prevention and control measures. This study took a different approach. Focusing on existing effective programs in a variety of settings accomplished two key goals. First, the study demonstrates that stormwater management does not have to be overwhelming. The case studies show on a practical level that stormwater management can be environmentally effective, economically advantageous, and politically feasible. Second, the case studies enable communities developing or improving stormwater programs to learn from their peers. In doing so, the case studies offer an outline for future successful stormwater management strategies.

ACKNOWLEDGMENTS

The authors extend their appreciation to all the communities, organizations, agencies, and individuals who provided information for this study; the technical consultants, peer reviewers, and groundtruthers for their helpful comments; and the volunteers and Natural Resources Defense Council staff who assisted with this study. The study was supported by a grant from the EPA under Section 104(b)(3) of the Clean Water Act.

LITERATURE CITED

- Bannerman, R. T., D. W. Owens, R. B. Dodds, and N. J. Hornewer (1993). "Sources of Pollution in Wisconsin Stormwater." *Water Science and Technology* 28(3-5): 241-259.
- Booth, D. B. (1990). "Stream-Channel Incision Following Drainage-Basin Urbanization." *Water Resources Bulletin* 26(3): 407-417.
- Booth, D. B. and L. E. Reinelt (1993). "Consequences of Urbanization on Aquatic Systems-Measured Effects, Degradation Thresholds, and Corrective Strategies." Proceedings,

Watershed '93: A National Conference on Watershed Management, Alexandria Virginia, pp. 545-550.

- Carpenter, S. R., N. F. Caraco, D. L. Correll, R. W. Howarth, A. N. Sharpley, and V. H. Smith (1998). "Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen." *Ecological Applications* 8(3): 559-567.
- Galli, J. (1990). *Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices: Final Report*. Metropolitan Washington Council of Governments, Washington, DC, 157 pp.
- Haile, R. W. et al. (1996). *An Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay*. Santa Monica Bay Restoration Project, Santa Monica, CA, 70 PP.
- Herzog, M., J. Harbor, K. McClintock, J. Law, and K. Goranson (1998). "Are Green Lots Worth More than Brown Lots? An Economic Incentive for Erosion Control on Residential Developments." *Journal of Soil and Water Conservation*, Accepted.
- Jones, R. C. and C. C. Clark, (1987). "Impacts of Watershed Urbanization on Stream Insect Communities." *Water Resources Bulletin* 23 (6): 1047-105 5.
- Klein, R. D. (1979). "Urbanization and Stream Quality Impairment." *Water Resources Bulletin* 15(4): 948-963.
- Lehner, P. H., G. P. Aponte Clarke, D. M. Cameron, and A. G. Frank (1999). *Stormwater Strategies: Community Responses to Runoff Pollution*. Natural Resources Defense Council, New York, NY, 269 pp. Separate
- Novotny, V. H. and Harvey Olem (1994). *Water Quality: Prevention, Identification, and Management of Diffuse Pollution*. Van Nostrand Reinhold, New York, 1054 pp.
- Schueler, T. R., (1994). The Importance of Imperviousness. *Watershed Protection Techniques* 1(3): 100-111.
- U.S. Environmental Protection Agency (1990). 40 CFR parts 122, 123, and 124, *National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges; Final Rule*. Federal Register, U.S. Government Printing Office, Washington, DC 55(222): 47992-47993.
- U.S. Environmental Protection Agency, (1997a). *Nonpoint Source Pollution: The Nation's Largest Water Quality Problem*. Accessed December 21, 1998, at URL <http://www.epa.gov/OWOW/NPS/facts/pointl.htm>.

U.S. Environmental Protection Agency (1997b) - Urbanization and Streams: Studies of Hydrologic Impacts, Office of Water, Washington, DC, EPA-97-009, 15 pp.

U.S. Environmental Protection Agency (1998a). 40 CFR parts 122 and 123 Part II, *National Pollutant Discharge Elimination System-Proposed Regulations for Revision Of the Water Pollution Control Program Addressing Storm Water Discharge; Proposed Rule*, Federal Register, U.S. Government Printing Office, Washington, DC 63(6): 1536-1643.

U.S. Environmental Protection Agency (1998b). *National Water Quality Inventory: 1996 Report to Congress*, EPA-97-008, 521 pp.