USE OF STORMWATER ENVIRONMENTAL INDICATORS IN URBAN RUNOFF NPDES PERMITTING AND WATERSHED MANAGEMENT IN THE SANTA CLARA BASIN, CALIFORNIA

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ABSTRACT

Under a grant from the Water Environment Research Foundation, the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) implemented 20 of the Center for Watershed Protection's 26 *Environmental Indicators to Assess Stormwater Programs and Practices*. The indicators were applied at two geographic scales: the 310-square-mile watershed of Coyote Creek and a 28-acre industrial catchment in the City of Santa Clara.

Results from implementing programmatic indicators stimulated improvements, now in progress, to the tracking and reporting of illicit discharges and industrial inspections. SCVURPPP will use the results of physical, hydrological, water-quality, and biological indicators to help inform and motivate action among fellow stakeholders in the Santa Clara Basin Watershed Management Initiative.

The ability to quickly make use of some indicator results is attributed to SCVURPPP's management program, including the adoption of Performance Standards and a continuous improvement process. Other indicators are generally indicative of stream functions and are most useful when they are organized in a framework that provides a unifying theme to communicate a compelling story to stakeholders and public.

KEYWORDS

Stormwater, NPDES, indicators, BMPs, watershed management

INTRODUCTION

The Center for Watershed Protection (CWP) has developed "stormwater environmental indicators" and a methodology for their use in re-evaluating stormwater management program goals, assessing program activities, and implementing monitoring (Claytor and Brown, 1997). The CWP recommends using programmatic and social indicators, in addition to measures of water quality and biological health, to gauge the effectiveness of urban stormwater programs.

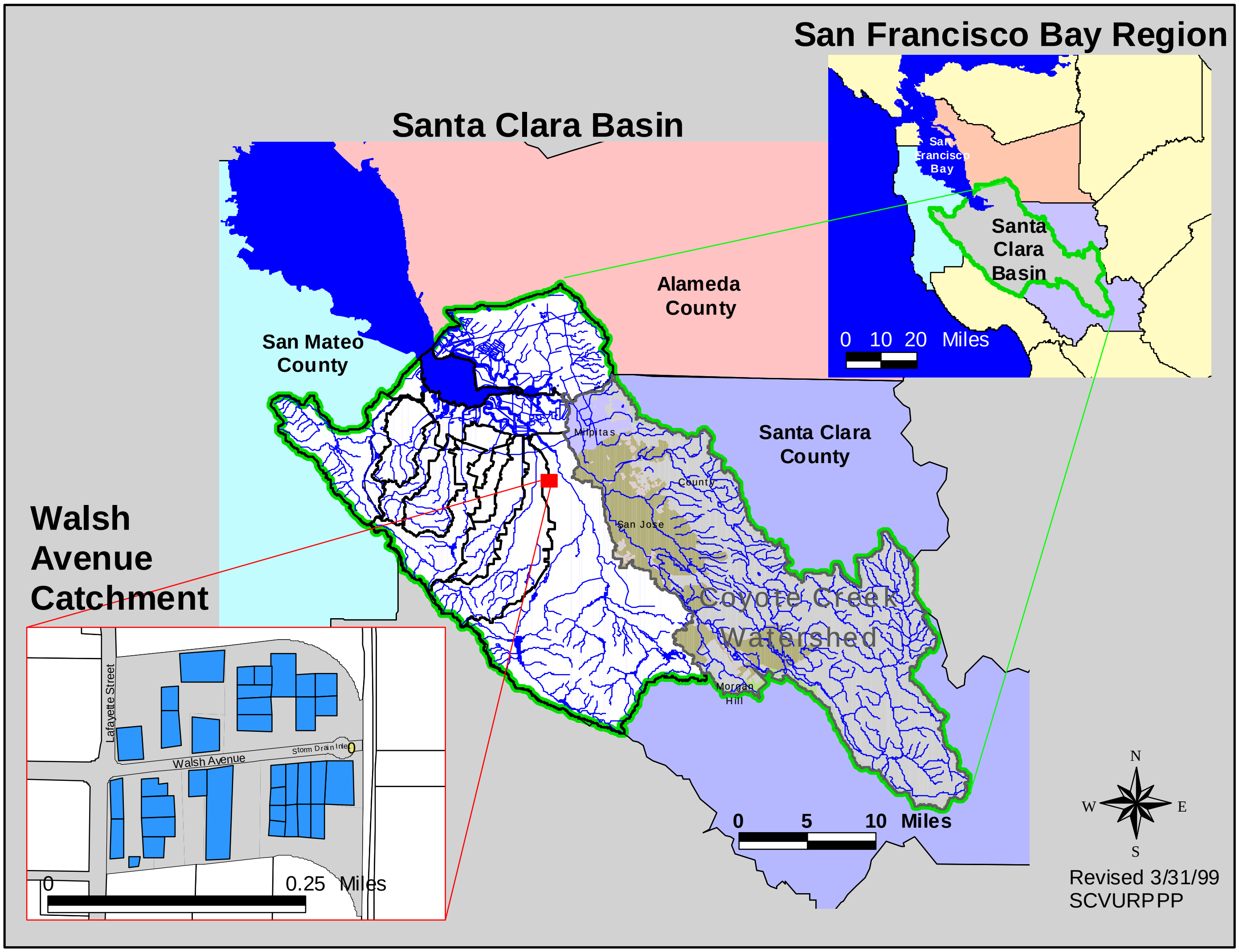


Figure 1. Study Area

Under a Water Environment Research Foundation grant, the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) demonstrated 20 of the CWP's 26 stormwater environmental indicators (Table 1) in the Santa Clara Basin, California. The indicators were implemented at two scales: the 310-square-mile watershed of Coyote Creek (which includes the eastern portion of the City of San Jose) and a 28-acre industrial catchment along Walsh Avenue in the City of Santa Clara (Figure 1). The semi-arid climate is typical of California's coast from the San Francisco Bay area southward.

The project included preparation of 15 technical memoranda describing methods, results and conclusions from application of the 20 indicators. Two final reports will be available in October 2000. A technical report will summarize and integrate the indicator results, and a guidance manual will include recommendations for applying the indicators in the semi-arid west and throughout the U.S.

The demonstration project is presented in a companion paper (Cloak et al. 2000). This paper describes how the SCVURPPP is implementing the results of the project.

GAUGING STORMWATER PROGRAM “EFFECTIVENESS”

The 1987 amendments to the Clean Water Act – and USEPA’s 1990 Phase I stormwater regulations – established a common national framework for stormwater management programs. The regulations require municipalities to effectively prohibit non-stormwater discharges to storm drains and to implement, to the maximum extent practicable, Best Management Practices (BMPs) for activities that can introduce pollutants to storm drains. These activities are typically organized into program elements:

- Preventing Illicit Connections and Illegal Discharges
- Reducing Industrial and Commercial Sources
- Municipal Maintenance Activities (including road and sewer maintenance)
- Construction Sources and Long-term Effects of New Development

Municipalities must also educate the public about stormwater pollution prevention.

The “maximum extent practicable” standard is somewhat vague. The specific BMPs selected (and the extent to which they are implemented) depend on local conditions, including climate, land use, mix of industries, drainage system characteristics, and available resources. It is up to local stormwater programs to design an “effective” set of stormwater pollution control measures.

The definition of “effectiveness” is likewise elusive. EPA’s 1990 Phase I storwmater regulations state that NPDES permit applications should include “estimated reductions in loadings of pollutants from discharges of municipal storm sewer constituents from municipal storm sewer systems expected as the result of the municipal storm water quality management program.”

However, variability in stormwater pollutant concentrations and flows raised questions as to whether pollutant loads were a practical or meaningful measure or program effectiveness. Claytor and Brown (1997) state: “Stormwater runoff management has traditionally focused on end-of-pipe controls and compliance with chemical and physical criteria, usually set by Environmental Protection Agency (EPA) or state environmental protection agencies. In part, due to EPA stormwater permit requirements, many municipalities and industries have invested significant time, money, and manpower towards characterization of stormwater runoff and collection of chemical and physical data for receiving streams (or water bodies). Recently, however, many stormwater management professionals have questioned the applicability and usefulness of these data to accurately describe existing conditions in the receiving water, evaluate the overall integrity of the aquatic community, and assess the degree of improvement in the stream system (Swietlik et. al 1994)."

In other words, measured reductions in pollutant loadings should not be the only — and are not necessarily the most meaningful —objective of municipal stormwater programs.

In 1999, when EPA issued Phase II stormwater NPDES regulations to smaller municipalities, the agency promoted a general approach to evaluating program effectiveness, the appropriateness of identified best management practices, and progress towards achieving identified measurable goals.

STORMWATER NPDES PERMIT REAPPLICATION

The SCVURPPP/WERF indicator demonstration project coincided with preparation of SCVURPPP's application to the California Regional Water Quality Control Board for the San Francisco Bay Region (Regional Board) for a second 5-year renewal to its Phase I NPDES permit. The permit sets conditions for stormwater discharges from San Jose, Sunnyvale, Palo Alto, Santa Clara, and the other cities within the "Silicon Valley." The permit lists Santa Clara County and the Santa Clara Valley Water District, which operates and maintains creeks and flood control channels within the basin, as additional Co-permittees.

Performance Standards

Under an NPDES permit first issued in 1990, municipal Co-permittees have implemented mandated pollution-prevention efforts. The level of effort is codified in Performance Standards that apply to illicit discharge elimination, industrial inspection, street maintenance, catch-basin cleaning, construction inspection, review of plans for new developments, and operation of water supply systems. The Co-permittees expend several hundred thousand dollars annually to educate the public to avoid polluting urban runoff.

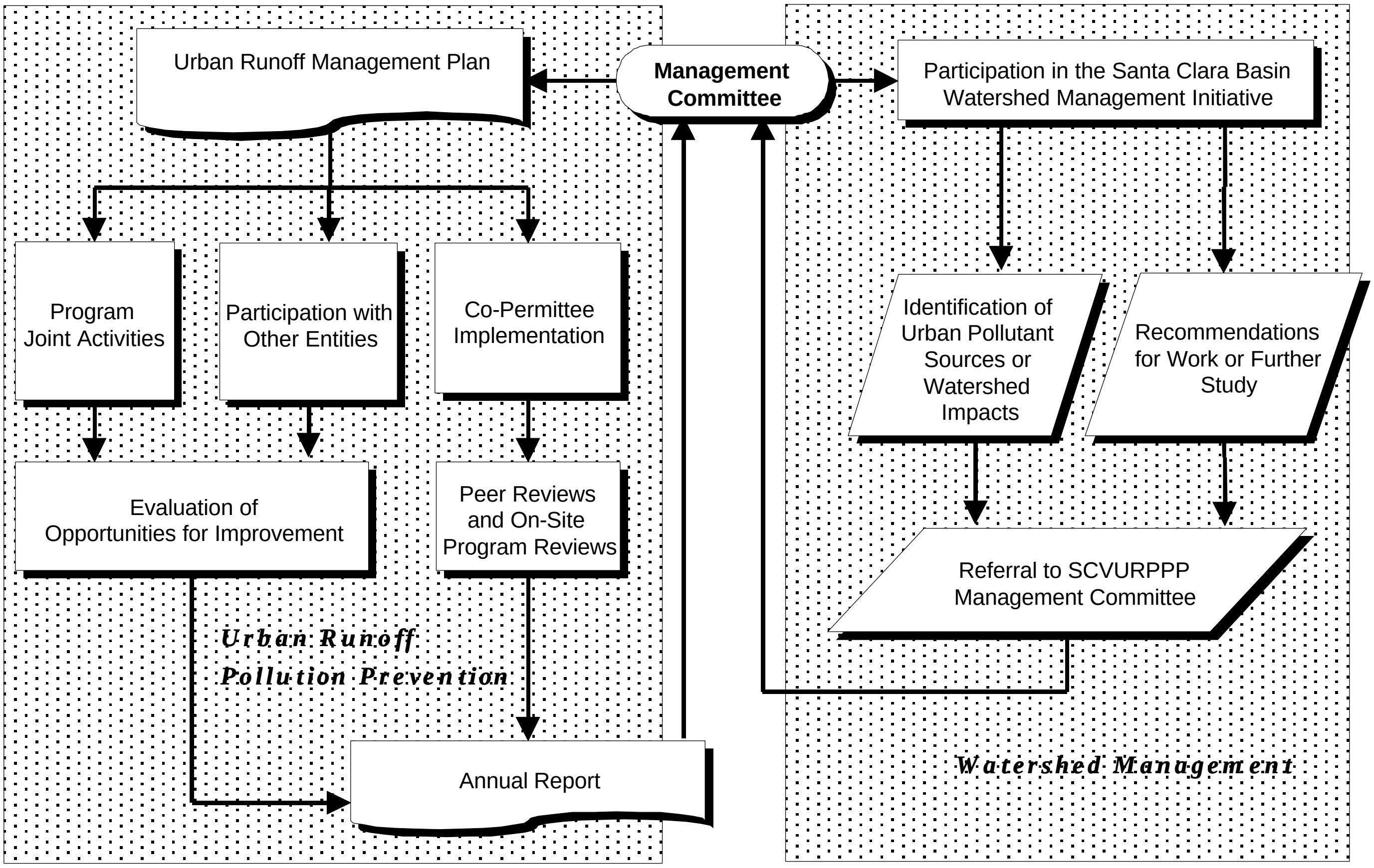
Watershed Management

The Co-permittees recognize that this comprehensive suite of mandated control measures and BMPs may be insufficient to control the effects of urbanization on local streams. The Co-permittees are participating in a stakeholder-based watershed management initiative.

USEPA and the California Regional Water Quality Control Board for the San Francisco Bay Region initiated the the Santa Clara Basin Watershed Management Initiative (SCBWMI) in 1996. They have been joined by a diverse group of stakeholders, including the California Department of Fish and Game, the San Jose/Silicon Valley Chamber of

Figure 2

Continuous Improvement



Commerce, the Home Builders Association of Northern California, the Santa Clara Valley Audubon Society, and many others.

The stakeholders agree that: "Many diverse factors impact the basin, including water quality, land use, flood protection, water supply and habitat protection. A holistic strategy is required to confront and manage these issues. By addressing all sources of pollution that threaten the Bay, we can achieve a sustainable balance of human and natural uses and needs. Regulators, along with local community, environmental, agricultural and business representatives, must maintain a continuous, productive dialogue to protect the Santa Clara Basin" (SCBWMI, 1999).

Currently, SCBWMI members are conducting a watershed assessment to document the basin's environmental conditions and regulatory framework. SCBWMI participation ensures a coordinated approach to data collection and allows stakeholders to plan pollution reduction and prevention activities. When completed in 2001, the assessment will be the foundation for a regional watershed management plan.

Continuous Improvement

The SCVURPPP is dedicated to a process of continuous review and improvement (Figure 2), which includes seeking new opportunities to control stormwater pollution and to protect beneficial uses. When such opportunities arise, the Program revises, updates and adds to its activities, control measures, BMPs and Performance Standards. The changes are documented in annual reports.

As the SCBWMI assesses urban watersheds and develops a watershed management plan, stakeholder workgroups are identifying special studies and institutional needs that the Program (among SCBWMI stakeholders) is best suited to implement. The Program has identified four general areas of support for the SCBWMI:

1. Support for field work and other watershed assessment tasks.

2. Administrative support for SCBWMI workgroups.

3. Managing watershed data and making it accessible.

4. Support related to land use issues in watershed planning.

DEMONSTRATION PROJECT RESULTS

In the Coyote Creek watershed, our baseline was a 1979-1981 EPA-sponsored study that sought to identify the effects of urban runoff on water quality, sediment, fish, macroinvertebrates, attached algae, and rooted aquatic vegetation. In addition, the SCVURPPP monitored stormwater constituents and toxicity in the creek 1987-1996. In 1999, we sampled fish and assessed physical habitat at 18 locations in Coyote Creek, sampled surficial sediment at six locations, and sampled benthic macroinvertebrates at nine locations. We analyzed flooding, changes to stream morphology, and sources of imperviousness in the surrounding watershed. We also georeferenced reports of illegal dumping and known industrial and construction sites.

Eighteen of the Walsh Avenue catchment’s 32 businesses participated in a 1992 pilot industrial stormwater pollution control study. Drainage from the catchment was sampled and analyzed for pollutants 1989-1996 and again in 1999. We reviewed the City of Santa Clara’s inspection records and conducted on-site interviews with managers of 29 of the 32 businesses.

Coyote Creek’s physical habitat, stream geomorphology, and biological indicators are affected by reservoir releases, stream channel alterations, diverted flows, and a history of mining and grazing — all of which are typical for California streams, particularly those in urbanized areas. These factors have irreversibly altered the stream ecology.

Fish assemblages in Coyote Creek are much the same as they have been since the construction of a major dam in 1950. However, analysis of fish and macroinvertebrate indices showed changes in reaches that have urbanized since the 1979-81 study. A 70-fold decrease in illicit connections reported 1993-1998 suggests the cities' surveys and monitoring have effectively eliminated illicit connections to storm drains. A 1993-1998 trend toward fewer illegal dumping reports (for most incident categories) suggest that the Co-permittees' outreach, industrial/commercial inspections, response to dumping incidents, and enforcement have had an effect. Increased staff and public awareness, and a construction boom, may have contributed to the rising number of reports for other categories.

Businesses in the Walsh Avenue catchment are implementing more BMPs than in 1992, but we attributed this to the existence of other regulatory programs and generally heightened awareness, rather than the local urban runoff pollution prevention program's efforts. Nickel and lead concentrations apparently decreased, but toxicity due to high zinc concentrations was unchanged.

More detailed presentation of results appears in a companion paper (Cloak et al. 2000), in 15 interim technical memoranda, and in the final project report.

APPLICATION OF INDICATOR RESULTS TO SCVURPPP

The Center for Watershed Protection's indicator methodology proved useful in the context of watershed management and continuous improvement of the urban runoff Program (Figure 2):

- Development and refinement of programmatic and social indicators revealed new means to continuously improve the NPDES-permitted urban runoff program and to track its progress. These included recommendations to improve data collection and compilation, to georeference potential pollutant sources, and to link this information to storm drainage maps. This will facilitate reporting and targeting of Co-permittees' outreach and enforcement efforts. The recommendations will be implemented through updated and improved Performance Standards.

- Implementation of water-quality indicators, biological indicators, and physical indicators provided new and better information for assessing watershed condition. New perspectives were gained on the resilience of native fish populations, the extent to which dam releases and water diversions affect habitat in the lower watershed, the persistent effects of historical gravel mines, biological impacts associated with urbanization and construction of new storm drain outfalls, and an apparent problem of periodic suppression of dissolved oxygen concentrations in the most urbanized reaches. Consideration of this information by SCBWMI stakeholders should lead to specific management actions — some of which will be implemented, individually or jointly, by the SCVURPPP Co-permittees.

SCVURPPP is able to make timely use of results from the stormwater environmental indicators because it:

- has Performance Standards,
- pursues continuous improvement, and
- participates in a stakeholder-based watershed management initiative.

Without Performance Standards — which define the specific pollution-prevention measures to be implemented, and include standard operating procedures and workplans and milestones for updating those procedures — there would be little basis for evaluating the results of the programmatic indicators or for developing and implementing recommendations for continuous improvement.

Without an established process of continuous improvement, the results of indicators would carry “regulatory baggage;” that is, would suggest that the Co-permittees were falling short of an elusive “maximum extent practicable” standard. The continuous improvement process recognizes that “maximum extent practicable” is a moving target and that the Co-permittees must expect continuous change within their pollution-prevention programs. Further, the continuous improvement policy insures that budget and personnel are assigned to implement recommended improvements timely.

Without participation in stakeholder-based watershed management, the Program would not be able to easily inform and motivate other watershed stakeholders to contribute toward management actions that can improve stream functions.

In the past, measurements of ambient water and sediment quality have been generally compared to thresholds that evidence (more or less accurately) water-body “impairment.” Development of biological indicators such as fish assemblages and macroinvertebrate indices (sometimes dubbed “biocriteria”) has largely followed suit. The application of thresholds is intended to facilitate fair and consistent decision-making within regulatory agencies, particularly regarding the listing of water bodies as “impaired” on EPA’s 303(d) list.

However, to successfully inform and motivate watershed stakeholders, a different approach may be warranted. Indicators can be used as an essential “building block” in achieving an understanding that can lead to informed, coordinated action.

Kimberly Walesh of Collaborative Economics has illustrated the role of indicators as shown in Figure 3 (Walesh 2000).

Each of these elements is necessary, because:

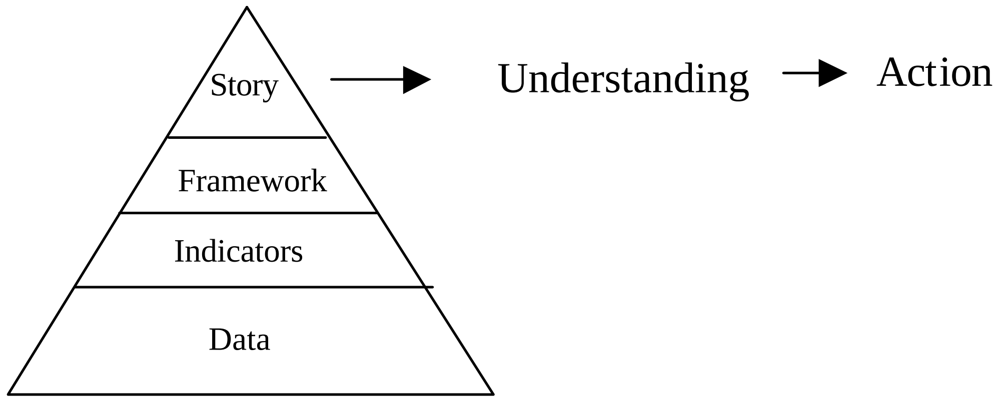


Figure 3. Relationship of Indicators to Actions

- Without a compelling, well-communicated story, it is difficult to catalyze action.
- Without an organizing framework to provide a unifying theme, it is difficult to choose a consistent set of indicators.
- Without indicators that organize the data, the data are impenetrable.
- Without timely, relevant data, a story's significance is dramatically reduced.

To inform and motivate watershed stakeholders, physical, hydrological, chemical and biological indicators are best used to "tell the story" of how a watershed has changed, and is changing, in response to human influences. A compelling, well-communicated story can stimulate actions to improve the watershed.

Our experience in the Coyote Creek watershed suggests the most useful framework must incorporate an understanding of how stream hydrogeomorphology — the flow of water and sediment, and the continual re-creation of in-stream structures by natural and human influences —relates to stream biological functions and the associated aquatic life beneficial uses.

CONCLUSIONS

To be "effective," a stormwater program should be in compliance with its permit — and should also be coordinated and integrated with its community's broader efforts to preserve and enhance the local environment.

Results from the SCVURPPP's demonstration application of stormwater environmental indicators show the opportunity to adapt the Center for Watershed Protection methodology to support new relationships between NPDES-permitted urban runoff programs and watershed management.

This is particularly important in California and the semi-arid west, because:

- Western urban streams are more likely to be affected by flow regulation and diversion, barriers to fish migration, sediment budget, and other factors outside the direct control of city government.

- In many semi-arid areas, the historical human impacts of mining, agriculture, grazing, and urbanization, and introduction of exotic species, have irreversibly altered aquatic ecology. This complicates the process of defining watershed goals.

- In California and the West, environmental management responsibilities and local government power are typically dispersed among many agencies with different perspectives and goals.

The suite of indicators developed by the CWP can serve stormwater pollution prevention programs in two distinct and complementary ways, by:

1. Facilitating continuous improvement of permit-mandated pollution-prevention activities.

2. Catalyzing actions by other stakeholders to help preserve and enhance local waters.

To successfully apply indicators for the first purpose, programs should be already implementing routine mandated pollution-prevention measures. The extent and means of implementation should be documented in performance standards. To insure that the results of indicators are incorporated into program activities, programs should be committed to ongoing program improvements and should have a methodology for implementing those improvements on an annual cycle.

To successfully use indicators to address the most significant impacts of urbanization on streams, stormwater programs will need to be actively involved with other municipal agencies, regulators, advocacy groups, and private interests in a stakeholder process to preserve and enhance the watershed. These indicators will be most effective when they are implemented in the context by an organizing framework to create a compelling, well-communicated story.

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