Tools to Measure Source Control

Program Effectiveness

A recent study on commercial and residential source control programs found that little information is available on evaluating program effectiveness (WERF, 1998). Two factors contribute to this phenomenon: the difficulty of measuring the effectiveness of programs targeting diverse sources and the unavailability of tools for this purpose.

The goal of any source control program is improvement of environmental conditions. When environmental improvement must be addressed through reductions associated with residential and commercial sources, measurable changes may take place slowly. As the sources become more diverse and less amenable to traditional regulatory approaches, source control programs become more complicated and must increasingly rely on untested strategies. In addition, nonregulatory approaches rely heavily on public outreach, which often yields results in small increments over a relatively long time frame. Therefore, effectiveness tools that measure intermediate results are necessary to ensure that programs are heading in the right direction. Tools are needed to measure not only environmental improvements, but the intermediate steps of increased awareness and behavior change as well.

The purpose of this project is to develop evaluation tools that are applicable to a range of commercial and residential source control programs with varying target pollutants, environmental conditions and available program resources. The project is being conducted in two phases. This report describes the results of the first phase, in which a model framework was developed for incorporating effectiveness measurement into a source control program and tools were evaluated by assessing existing efforts to measure program effectiveness. In addition, examples of how the framework and tools can be used as well as factors to consider when selecting an effectiveness measurement tool are also presented. Findings with respect to benefits realized from program evaluation, barriers to conducting evaluation, and lessons learned from other fields (that is, social marketing and education) are also presented. During the second phase of the project, the framework and tools will be tested through demonstration projects conducted by stormwater and wastewater agencies as part of their pollution prevention programs.

PROJECT 98-WSM-2

Tools to Measure Source Control Program Effectiveness

by:

Betsy Elzufon
Larry Walker Associates

2000

Water Environment Research Foundation

ENVIRONMENTAL STEWARDSHIP THROUGH
INNOVATIVE SCIENCE AND TECHNOLOGY

The Water Environment Research Foundation (WERF) is a not-for-profit organization providing a balanced water quality research program addressing current wastewater research needs and forecasting future directions. WERF was established to advance science and technology for the benefit of the water quality profession and its customers. WERF manages research under three major thrust areas: collection and treatment systems, human health effects and products, and watershed and ecosystems management.

To ensure that all areas of the water quality profession are represented, WERF's governance includes: a 15-member board of directors consisting of individuals from municipal utilities, corporations, and academia; and a research council made up of 17 world-renowned experts in water quality. In addition, a Utility Council and Corporate Council composed of subscribing organizations are actively involved in research program management.

WERF is funded by its subscribers, which include utilities, municipalities, industrial organizations, and corporations. Subscribers guide WERF's research program by participating in agenda-setting exercises and in the research itself. While WERF coordinates all research-related activities and manages each research project, the investigations are carried out by individual organizations, primarily municipal water and wastewater utilities, universities, industrial organizations, commercial firms, government laboratories, or a team of these entities. To ensure objectivity in research endeavors, an independent advisory committee (the Project Subcommittee) of distinguished scientists and engineers helps select researchers, oversees the studies, and provides periodic review and advice.

Project Subcommittee

Tudor Davies
U.S. Environmental Protection Agency, Office of Science and Technology (Research Council Liaison)

Geoff Brosseau
Bay Area Stormwater Management Agencies Association

Jeff Lape
U.S. Environmental Protection Agency, Office of Water

William Leo
Hydroqual, Inc.

Margie Nellor
Los Angeles County Sanitation Districts

Daniel Rourke
San Francisco Water Pollution Prevention Program

Project Team

Betsy Elzufon (Principal Investigator)
Larry Walker Associates

Nimi Mahadevan
Michelle Vikupitz
Larry Walker Associates

Chris Harris
Reed Harris
Adele Sonora
Harris and Company

BENEFITS

- Provides information on effectiveness measurement for a variety of stormwater and wastewater pollution prevention and public education projects.
- Provides cost information for implementing pollution prevention programs and measuring program effectiveness.
- Lists factors/participation rates that can be used for identifying effective control strategies and planning pollution prevention and source control programs.
- Lists effectiveness measurement tools and describes how they are used.
- Describes a process/framework for developing an effective pollution prevention or source control program.
- Discusses how effectiveness measurement is conducted in related fields including social marketing and education.
- Identifies barriers to conducting effectiveness measurement and suggests approaches to overcoming these barriers.

Water Environment Research Foundation

TABLE OF CONTENTS

**Water Environment
Research Foundation**

LIST OF TABLES

Water Environment
Research Foundation

LIST OF FIGURES

Water Environment Research Foundation

EXECUTIVE SUMMARY

Source control programs targeting commercial and residential activities have been implemented around the country in an effort to reduce pollutant levels in stormwater and wastewater. These programs have been designed to identify pollutants of concern, pollutant sources, and strategies to control these sources. However, efforts to measure program effectiveness and quantify environmental benefits resulting from these programs have been met with limited success. Program effectiveness refers to how successful a program has been with respect to having a positive impact on environmental conditions or the increased awareness and behavior changes that lead to improvement in the environment.

A recent study on commercial and residential source control programs found that little information is available on evaluating program effectiveness (WERF, 1998). Two factors contribute to this: the difficulty of measuring the effectiveness of programs targeting diverse sources and the unavailability of tools for this purpose.

Some issues to consider when developing an approach to assessing commercial and residential source control programs include how environmental improvement occurs and the importance of evaluation for programs targeting diffuse sources.

The goal of any source control program is improvement of environmental conditions. When environmental improvement must be addressed through reductions associated with residential and commercial sources, measurable changes may take place slowly. As the sources become more diverse and less amenable to traditional regulatory approaches, source control programs become more complicated and must increasingly rely on untested strategies. In addition, nonregulatory approaches rely heavily on public outreach, which often yields results in small increments over a relatively long time frame. Therefore, effectiveness tools that measure intermediate results are necessary to ensure that programs are heading in the right direction. Tools are needed to measure not only environmental improvements, but the intermediate steps of increased awareness and behavior change as well.

Therefore, it is helpful to break down the process by which environmental benefit is achieved into four stages. The first stage is to develop and implement a source control program. The next stage is to create awareness of the issues for the appropriate audience. The third stage is to motivate this audience to modify its behavior. Finally, once the necessary behavior is modified, a reduction in source inputs and subsequent improvement in the environment is the desired result. If each stage of the process is assessed individually, then changes may be measurable and, therefore, easier to quantify. Tools to assess each stage should be tailored to the unique aspects of a particular stage.

In addition to dealing with issues associated with diffuse sources, most source control program managers have limited resources with which to conduct their programs and need to focus their efforts effectively. Measuring program effectiveness is critical to helping managers focus their resources on the most effective control measures and improving the overall results of their efforts.

The purpose of this project is to develop evaluation tools that are applicable to a range of commercial and residential source control programs with varying target pollutants, environmental conditions, and available program resources. The project is being conducted in two phases. In the first phase, a model framework was developed for incorporating effectiveness measurement into a source control program and tools were evaluated by assessing existing efforts to measure program effectiveness. Examples of how the framework and tools can be used as well as factors to consider when selecting an effectiveness measurement tool are also presented. During the second phase of the project, the framework and tools will be tested through demonstration projects conducted by stormwater and wastewater agencies as part of their pollution prevention programs.

Procedures for developing a pollution prevention program and incorporating effectiveness measurement into the program that are used in Phase 1 are summarized in the following section. Effectiveness measurement tools as well as considerations when selecting a tool for a program are discussed, based on case studies and other examples. In addition, findings and recommendations are presented.

Process Summary

Processes and step-by-step considerations to developing a source control program are summarized as follows:

1. ***Identify the issue.*** An effective source control program has a clearly defined issue, which can be defined by:

   ♦ Identifying a pollutant of concern or a waste stream, and
   ♦ Establishing a base line by determining pollutant loading or waste stream volume.

2. ***Identify and assess sources.*** Sources may be identified via monitoring, agency records, or by reviewing the literature and other agency programs. Once sources are identified,

   ♦ Determine the significance of the source by estimating its contribution to the total pollutant loading or waste stream volume, and
   ♦ Assess the source's controllability with respect to the agency's ability to work with the source. This assessment will include several factors such as jurisdictional and political concerns.

3. ***Determine available control strategies.*** To identify possible control strategies for each source:

   ♦ Consider control strategies already in use by the agency that target similar sources,
   ♦ Review strategies used by other agencies for this source, and
   ♦ Brainstorm to come up with new ideas that would work in the service area.

Water Environment Research Foundation

4. ***Evaluate and prioritize control strategies.*** The following should be assessed to determine which control strategies are most likely to achieve measurable results:

- ♦ *Participation* — What portion of the targeted audience is likely to make the desired behavior change?
- ♦ *Loading* — What portion of the source's total loading will be eliminated if the entire targeted audience makes the desired behavior change?
- ♦ *Cost* — How much will it cost the agency to implement the program and how much will it cost the targeted audience?

Determine an estimated load reduction from the estimated participation and loading for each control strategy and compare it to the estimated cost of the control strategy to determine which strategies are most worthwhile.

5. ***Establish a goal.*** A goal may be set at any point during the development process. The goal is the desired outcome of the program, and may be set based on:

- ♦ A reference condition (that is, the condition that would exist without human interference);
- ♦ The reduction necessary to meet a permit limit or other regulatory or environmental standard;
- ♦ A reduction that can be realistically achieved based on the estimated load reductions determined in the previous step; and
- ♦ Performance necessary to meet an intermediate goal (for example, compliance rate with a regulatory program and response rate to an outreach program).

6. ***Implement the program.*** Part of program implementation is the selection of an effectiveness measurement tool to assess the program. Before choosing assessment tools, it is important to determine what information is being sought about the program. The tools are then chosen based on:

- ♦ The ability to measure achievement of the goal;
- ♦ The target audience and control strategy chosen;
- ♦ Whether or not assessment is necessary during the program or can be deferred until the program is completed; and
- ♦ What stage the program is focusing on (that is, increased awareness, behavior change, and environmental improvement).

Elements that allow effectiveness measurement are put in place at the beginning of program implementation. For example, base line surveying or monitoring is conducted, a telephone number to receive responses to a campaign is set up, or survey cards are added to outreach materials.

7. ***Evaluate effectiveness.*** Based on the effectiveness measurement, the agency determines what it has learned from the program as follows:

- ♦ Has the program's goal been achieved?
- ♦ What were the most effective aspects of this project?
- ♦ What changes need to be made to achieve better results?

8. ***Modify the program.*** The results of the effectiveness measurement will help determine future directions for the program with respect to the following:

   ♦ Additional strategies to address this source if the desired results were not achieved;
   ♦ Alternative sources to work with if no further reductions are possible from this project's source; and
   ♦ New issues to pursue if the pollutant or waste stream issue was adequately addressed by the program.

Selecting an Effectiveness Measurement Tool

While effectiveness measurement of source control programs is not widespread, agencies representing a range of sizes, focuses, and pollutant issues were found to be measuring the effectiveness of their programs. Examples of these agencies are presented in Chapters 2, 3, and 4 of this report; the agencies are also listed in Table ES-1.

Effectiveness measurement tools identified in this report include:

♦ Surveys
  — Quantitative
  — Targeted
  — Telephone banking;
♦ Group feedback
  — Focus groups
  — Workshops;
♦ Pilot studies;
♦ Environmental analyses;
  — Effluent/receiving water monitoring;
  — Discharger sampling;
♦ Tracking responses;
♦ Tracking sales;
♦ Modeling;
♦ Cost-benefit analyses;
♦ Inspections/site visits;
♦ Participation rates; and
♦ Estimated load reductions.

Selection of effectiveness measurement tools by source control programs is influenced by the following factors:

♦ Target audience (that is, business, residential, schools, agriculture, and so on);
♦ Timing, with respect to project planning and implementation (that is, before, during, or after a project is conducted); and
♦ Stage, with respect to environmental improvement (that is, program implementation, increased awareness, behavior change, and environmental improvement).

Based on Table 5-5, the effectiveness tools that are most appropriate to a source control strategy may be chosen based on the following considerations:

Water Environment Research Foundation

Table ES-1. Examples Used in the Phase 1 Report

Program	Project	EPA Region	Program Type*	Program Audience
City of Hayward	Vehicle washing	9	WW	Business
Palo Alto RWQCP	Mercury P2 Plan	9	WW	Residential
Palo Alto RWQCP	Thermometer Turn-Ins	9	WW	Residential
San Francisco WPPP	Public Education Program	9	WW	Residential
Contra Costa Clean Water Program	Public Education Program	9	SW	Residential
City of Davis	Healthy Gardens Program	9	WW	Residential
King County LHWMP	Facility Managers Project	10	HW	Business
Contra Costa Clean Water Program	High School Outreach	9	SW	Schools
Palo Alto RWQCP	Silver Program	9	WW	Business
Novato Sanitary District	Copper Program	9	WW	Local Gov't
West County Wastewater District	Vehicle Service Facility Program	9	WW	Business
Union Sanitary District Pollution Prevention	Printers Program	9	WW	Business
San Francisco WPPP	Residential Guides	9	WW	Residential
Palo Alto RWQCP	Car Wash Coupons	9	WW	Residential
King County Hazardous Waste Mgmt. Program	Hazardous Household Product Use	10	HW	Residential
Central Contra Costa Sanitary District	Pesticide Outreach Program	9	WW	Residential
University of California, Berkeley	Pesticide Use Habits	9	SW	Residential
Sacramento Stormwater Program	Stormwater Program	9	SW	General
Los Angeles County Stormwater Program	Business Outreach	9	SW	Business
Montgomery County DEP	Composting Program	3	Solid Waste	Residential
King County LHWMP	On-site Consultation Team	10	HW	Business
Chesapeake Bay	Businesses for the Bay	3	Watershed	Business
Palo Alto RWQCP	Clean Bay Business Program	9	WW	Business
Bay Area Stormwater Management Agencies Assoc.	Surface Cleaner Program	9	SW	Business
Wisconsin Department of Agriculture	Nutrient Management Pilot Project	5	Watershed	Agriculture
Sacramento Stormwater Program	Copper Control Measures	9	SW	Business
Contra Costa Clean Water Program	Public Education Program	9	SW	Residential
City of Greenville	Pesticide Outreach	6	WW	Residential
San Francisco WPPP	Public Education Program	9	WW	Residential
Los Angeles County Stormwater Program	Audience Segmentation Study	9	SW	Residential
Washington State Dep't. of Ecology	Water Education for Teachers	10	Watershed	Schools
King County LHWMP	Envirostars	10	HW	Business
Western Lake Superior Sanitary Dist.	Dental Program	5	WW	Business
King County LHWMP	Green Gardening/ Natural Lawn Care	10	HW	Residential
King County LHWMP	School Program	10	HW	Schools

* WW = Wastewater Program, SW = Stormwater Program, HW = Hazardous Waste Program

♦ **Programs targeting business audiences.** Tools commonly used include measurement of participation or compliance rates, discharger sampling, and site visits/inspections. Other tools that have been used successfully include cost-benefit analysis, estimated load reductions, and focus groups. Participation rates are a useful measure when the control strategy used is a recognition or certification program. Discharger or effluent sampling is used most effectively when a specific business category is targeted. Effluent or influent sampling is an effective indicator of program performance only if a single source (that is, business category) is responsible for the major portion of a pollutant's loading.

♦ **Programs targeting residential audiences.** Most of the control strategies used for this audience are based on educational outreach materials and the methods of advertising this information to the public. Effectiveness measurement tools commonly used include quantitative and targeted surveys, tracking responses, and focus groups. Other tools that have been used successfully when adequate data are available include estimated load reductions, tracking sales, effluent toxicity, and modeling.

- ♦ ***Assessment during program planning.*** The most commonly used tools during the planning process include estimated load reductions, focus groups, modeling, and quantitative surveys.
- ♦ ***Assessment while a project is being conducted.*** Certain tools can be used to assess a program as it is being implemented. These tools include inspections/site visits and participation rates for business-oriented projects and tracking responses or sales patterns for residential audience projects.
- ♦ ***Assessment after a project is completed.*** Discharger and effluent sampling are conducted to assess the impact of an implemented project that targets a business audience. Targeted surveys are used to assess the impact of an outreach program on the residential sector, specifically with respect to whether workshops or education materials resulted in positive behavior changes. Quantitative surveys can also be used to assess the impact of residential outreach, specifically with respect to the overall impact of an advertising campaign.

Findings and Recommendations

Based on the information presented in this report, findings concerning benefits realized from program evaluation, barriers to conducting evaluation, and lessons learned from other fields are discussed in this section. In addition, recommendations are made for conducting demonstration projects that will test the framework and tools presented in this report.

Incentives and Barriers to Evaluation

As shown in many of the examples used in Phase 1 of this project, valuable information can be obtained from program evaluation. Benefits realized from effectiveness measurement include gaining support and funding for a program, identifying the best outreach methods, targeting a program to the right audience, and keeping the program on track. Agencies who have institutionalized effectiveness measurement or conducted program assessment for a number of years use these tools to plan their programs, choose where to focus resources, and determine how to modify their programs to improve them. These agencies also use assessment results to gain management support for their programs and to obtain additional funding. The agencies have been monitoring the effectiveness of their programs for so long that they instinctively know which strategies will work best in certain situations. Because their programs are so effective, the agencies appear to have more resources available to them. While their resources may not be much greater than programs of similar size, the agencies are able to focus efforts more effectively and get more "bang for their buck."

Although there are good reasons to conduct evaluation, many agencies avoid effectiveness measurement for a variety of reasons such as the following:

- ♦ Evaluation is too expensive.
- ♦ "I don't have the time or energy to do a good evaluation, so it's not worth bothering with at all."
- ♦ "I'm afraid that I'll find out my program is ineffective. It may look like we haven't done anything or wasted money and then we'll be required to do more."
- ♦ "I won't learn anything useful from evaluation."
- ♦ "I don't know how to evaluate my program."
- ♦ "My boss doesn't care about evaluation and I''ve never had to do it before, so why should I start now?"

- The only meaningful measure of a program's impact is changes in pollutant levels in influent, effluent, or sludge.
- There are no well-defined indicators to measure stormwater program performance.

Lessons Learned from Other Fields

Evaluation is used in commercial and social marketing and in education. In many respects, the approaches and tools used are similar to the framework and tools described in this report. Some additional tools and approaches used by market researchers and educators are summarized below.

Social marketing, which has been widely used to promote public health issues, has been used more recently to address environmental protection issues. The approach to developing a social marketing program is similar to the framework presented here, and encompasses planning, development, implementation, and assessment phases. Surveys and focus groups are widely used. Other tools employed in social marketing research include in-depth interviews, gatekeeper audits, central site interviews, forced exposure, and readability testing. In addition, some approaches that may be applicable to source control program effectiveness measurement include:

- Using survey data available from general marketing databases;
- Conducting a survey to assess an audience's knowledge, attitude, and practices associated with the social issue (process and outcome are evaluated by comparing later survey results to the initial survey);
- Assessing existing information regarding "product competition" or reasons that the target audience will not adopt the desired practices; and
- Comparing results from a marketing campaign to trends observed with a control group.

Educators also use several assessment tools to evaluate their programs. In addition to surveys and traditional testing, tools used to assess informal education programs include the use of outside observers, group interviews with children using open-ended questions and checklists asked verbally, and precoded log sheets to assess ongoing classroom activities. Some unusual approaches to assess children included analysis of children's drawings and extensive comparison to control groups based on national survey data and/or students not involved in the studied program. Educators often had to work with limited budgets when conducting program assessment. Using standardized checklists and precoded log sheets were two less expensive approaches. For each of these approaches, however, an initial time investment was necessary to train people to use the materials and to ensure that the forms were completed and returned.

Recommendations for Demonstration Projects

The framework and tools presented in this report will be tested by conducting demonstration projects with stormwater and wastewater source control programs. To obtain as much information as possible about source control program effectiveness measurement, the demonstration projects should be developed based on the following recommendations:

- Each demonstration project should follow the eight steps of the framework described at the beginning of this Executive Summary and use one or more of the effectiveness measurement tools also described earlier.

◆ Cost should be assessed for each effectiveness measurement tool. Identifying low-cost approaches to effectiveness measurement should be emphasized.
◆ Staffing requirements for each tool should be assessed with an emphasis on tools that can be used by agencies with small staffs.
◆ Different target audiences and pollutants should be the subject of each project.
◆ Demonstration projects should employ evaluation tools not previously used by the particular agency.
◆ Ease of use and applicability to other projects should be assessed for each evaluation tool.

Water Environment
Research Foundation

LIST OF ACRONYMS

BASMAA	Bay Area Stormwater Management Agencies Association
BMP	Best Management Practices
CCCWP	Contra Costa Clean Water Program
CCSF	City and County of San Francisco
CESQG	Conditionally Exempt Small Quantity Generators
DEP	Department of Environmental Protection
DHS	Department of Health Services
IPM	Integrated Pest Management
LHWMP	Local Hazardous Waste Management Program
RWQCP	Regional Water Quality Control Plant
SCWA	Sonoma County Water Agency
VINE	Volunteer-Led Investigations of Neighborhood Ecology
WET	Water Education for Teachers
WLSSD	Western Lake Superior Sanitary District
WPPP	Water Pollution Prevention Program

Water Environment
Research Foundation

CHAPTER 1.0

INTRODUCTION

Source control programs that target commercial and residential activities have been implemented throughout the United States in an effort to reduce pollutant levels in stormwater and wastewater. These programs have been designed to identify pollutants of concern, pollutant sources, and strategies to control these sources. However, efforts to measure program effectiveness and quantify environmental benefits resulting from these programs have been met with limited success. *Program effectiveness* refers to how successful a program has been with respect to having a positive impact on environmental conditions or the increased awareness and behavior changes that lead to improvement in the environment.

A recent study on commercial and residential source control programs found that little information is available on evaluating program effectiveness (WERF, 1998). Two factors contribute to this: the difficulty of measuring the effectiveness of programs targeting diverse sources and the unavailability of tools for this purpose.

Some issues to consider when developing an approach to assessing commercial and residential source control programs include how environmental improvement occurs and the importance of evaluation for programs targeting diffuse sources.

The goal of any source control program is improvement of environmental conditions. When environmental improvement must be addressed through reductions associated with residential and commercial sources, measurable changes may take place slowly. As the sources become more diverse and less amenable to traditional regulatory approaches, source control programs become more complicated and must increasingly rely on untested strategies. In addition, nonregulatory approaches rely heavily on public outreach, which often yields results in small increments over a relatively long time frame. Therefore, effectiveness tools that measure intermediate results are necessary to ensure that programs are heading in the right direction. Tools are needed to measure not only environmental improvements, but the intermediate steps of increased awareness and behavior change as well.

Therefore, it is helpful to break down the process by which environmental benefit is achieved into four stages. The first stage is to develop and implement a source control program. The next stage is to create awareness of the issues for the appropriate audience. The third stage is to motivate this audience to modify its behavior. Finally, once the necessary behavior is modified, a reduction in source inputs and subsequent improvement in the environment are the desired results. If each stage of the process is assessed individually, then changes may be measurable and, therefore, easier to quantify. Tools to assess each stage should be tailored to the unique aspects of a particular stage.

In addition to dealing with issues associated with diffuse sources, most source control program managers have limited resources with which to conduct their programs and need to focus their efforts effectively. Measuring program effectiveness is critical to help managers focus their resources on the most effective control measures and improve the overall results of their efforts.

The purpose of this project is to develop evaluation tools that are applicable to a range of commercial and residential source control programs with varying target pollutants, environmental conditions, and available program resources. The project is being conducted in two phases. This report describes the results of the first phase of the project. In this phase, a model framework was developed for incorporating effectiveness measurement into a source control program, and tools were evaluated by assessing existing efforts to measure program effectiveness. Examples of how the framework and tools can be used and factors to consider when selecting an effectiveness measurement tool are also presented. During the second phase of the project, the framework and tools will be tested through demonstration projects conducted by stormwater and wastewater agencies as part of their pollution prevention programs.

1.1   Report Organization

The organization of the report, outlined as follows, is designed to guide the reader through the process of developing and evaluating the effectiveness of a source control program:

Chapter 2 — Developing or Modifying a Program so It Can Be Evaluated. In this chapter, a framework is presented that serves as the basis for planning and evaluating a program. The individual steps in the process are then described. Finally, suggestions for incorporating evaluation into an existing program are presented.

Chapter 3 — Effectiveness Measurement Tools. Specific tools and the applications for which they work best are described in this chapter.

Chapter 4 — Choosing the Best Effectiveness Measurement Tool. In this chapter, the reader is guided through a process that will help identify appropriate evaluation tools for a project.

Chapter 5 — Summary of Process and Findings. The process of selecting tools and incorporating them into a source control program is summarized. In addition, findings are presented regarding how evaluation has been used to assist agencies conducting source control programs.

Appendix A — Case Studies. Specific examples are used throughout the text to illustrate the use of the framework and effectiveness measurement tools. Starting in Chapter 3, these examples are presented as case studies. Some of the more detailed case studies are presented in the text as summaries of the major points (that is, program description, control strategy evaluated, evaluation tools used, and results); these case studies are presented in more detail in Appendix A. The case studies, which reflect programs using evaluation tools, were identified by reviewing source control efforts throughout the country to determine what tools have been developed — and are being used — to assess effectiveness. The case studies are intended to show how effectiveness can be measured by large and small agencies with a variety of pollutant issues and project goals.

CHAPTER 2.0

DEVELOPING OR MODIFYING A PROGRAM SO IT CAN BE EVALUATED

A successful source control program is one that is based on planning and preparing for evaluation from the outset. This preparation includes putting elements in place that will facilitate effectiveness measurement. In this chapter, a framework that emphasizes planning and allows evaluation tools to be effectively incorporated into source control programs is described. Factors to be considered for each framework element are also discussed. Finally, some suggestions are made for modifying an existing program to allow for evaluation.

2.1   Framework Planning Process

A framework planning process for developing a pollution prevention program that will produce measurable results was developed based on processes used by several agencies to develop strategies to address pollution issues. The steps in this process are as follows:

1.   Identify the issue,
2.   Identify and assess sources,
3.   Determine available control strategies,
4.   Evaluate and prioritize control strategies,
5.   Establish a base line or goal,
6.   Implement the program,
7.   Evaluate program effectiveness, and
8.   Modify the program.

An overview of how the framework planning process is used to develop a pollution prevention program is illustrated by a Hayward, Calif., program to address nonstormwater discharges (Mendoza, 1999). The City of Hayward's Source Control Program is responsible for implementing pretreatment, stormwater, and pollution prevention programs for its service area. Hayward's service area has a population of 126,000 and is served by a 12 Mgal/d treatment plant.

Hayward officials identified nonstormwater discharges of vehicle and exterior wash water as an issue to be addressed by their pollution prevention program (Step 1). Sources of these discharges were identified as car washes and other vehicle service facilities that wash cars, mobile power washers, and charity/fundraising car washes (Step 2). Control strategies were identified for each of these sources (Step 3). Strategies identified for car washes and vehicle service facilities were to obtain a permit requiring certain best management practices

(BMP), take cars to another permitted facility to be washed, or to stop offering car washing as a service. The strategy identified for mobile washers required that a form be submitted by the mobile washer for each facility worked at in the service area. Outreach was the strategy identified for schools and other organizations conducting fundraising car washes. These strategies were prioritized (Step 4), with permitting of car washes and vehicle service facilities receiving the highest priority. The strategies targeting mobile power washers and fundraising car washes were also decided to be worth implementing. The program set its goal as redirecting non-stormwater discharges from these sources to the sanitary sewer (Step 5). The program was implemented for car washes, vehicle service facilities, mobile power washers, and fundraising car washes (Step 6).

Car washes and vehicle service facilities were visited and offered the following options: obtaining a permit, taking cars elsewhere to be washed, or discontinuing car washing. Mobile power washers were asked to submit forms for each job location. Outreach was conducted at schools and other organizations that explained issues regarding nonstormwater discharges; outreach efforts also included offering to loan the organizations the equipment necessary to collect wash water and discharge it to a sanitary sewer. The program was evaluated based on participation rates and the volume of wash water diverted to the sanitary sewer (Step 7). As a result of the program, eight exterior wash permits have been issued, three mobile washers have registered with the City, and five organizations have requested car wash collection equipment. The City of Hayward estimates that approximately 28,000 gal/d of wash water have been redirected from the storm drain to the sanitary sewer. Based on evaluation results, City officials are satisfied with the program and plan to continue all of its elements (Step 8).

The aforementioned example represents a simplified version of how the process works. However, several factors are involved in each step, and there are specific elements associated with each step that facilitate effectiveness measurement. A more detailed example of how the process framework was used for the Mercury Pollution Prevention Plan (Larry Walker Associates, 1997) developed by the Palo Alto, Calif., Regional Water Quality Control Plant (RWQCP) is presented in the following section.

2.1.1   Identify the Issue
The first step in the planning process is to identify the issue to be resolved. For most wastewater and stormwater programs, this means identifying pollutants of concern. Pollutants of concern are determined based on several factors including permit limits that may be difficult to meet, the potential for a discharge to cause or contribute to a water quality objective being exceeded, or an adverse environmental condition (for example, decreasing fish or wildlife populations). The issue may be a waste stream rather than a specific pollutant, as was the case in the aforementioned Hayward example. Once the issue is identified, the rest of the process follows a logical progression of steps.

Palo Alto has identified mercury as a pollutant of concern. RWQCP releases mercury in the environment through the plant's treated effluent, ash from sludge incineration, and incinerator air emissions. Although these releases comply with all regulatory requirements, RWQCP has identified mercury as a pollutant of concern because of its persistence in the environment and its toxicity to humans and other environmental receptors. To determine how to best to address this pollutant of concern, Palo Alto further defined the issue by quantifying its annual influent loading for mercury (23 lb).

2.1.2   Identify and Assess Sources

The next step is to determine the sources of the identified pollutant and the controllability and significance of each source. First, the controllability of the source by the local agency is assessed. For some sources, such as permitted industries, the local agency has direct control over the source. Sources that originate within the service area (such as improper disposal of household products or commercial business activities) are also readily addressed by local agency efforts. However, other sources may require efforts outside the jurisdiction of the local agency. An example of such efforts is the modification of a commercial product to remove an ingredient. In addition, some sources are considered part of nature and difficult to address. Specific wastewater examples include pollutant levels in soil or human waste. Next, the significance of each controllable source is determined by estimating the loading contribution from each source and comparing it to the total influent loading. Values that are used for loading contributions may be taken from direct source monitoring in the service area or may be based on literature values or values measured by other agencies.

For Palo Alto, a list of sources was developed based on data from RWQCP's pretreatment program and other monitoring efforts. In addition, information available in the literature and from other source control programs was used to identify and quantify the significance of sources.

An assessment of the controllability of mercury sources identified by Palo Alto is summarized in Figure 2-1. Sources to control within RWQCP's jurisdiction include dentists, household products, and permitted industries. Laundry graywater and disposal of food wastes down the drain were determined to have some potential to be controlled by RWQCP. Sources over which RWQCP has limited control include mercury levels in food, soil, human waste, and stormwater inflow. There are also unidentified sources of mercury to the RWQCP influent. Further research is needed to identify those sources.

The estimated loading contributions for potentially controllable mercury sources in Palo Alto's service area are shown in Table 2-1. The most significant sources with respect to estimated loadings for Palo Alto included dental activities, improper thermometer disposal, and residential laundry graywater.

2.1.3   Determine Available Source Control Strategies

Strategies to address each of the sources that are determined to be controllable are then identified. These strategies are identified based on the experiences of other communities and strategies that have been used in similar situations.

Palo Alto identified strategies to address dentists, household products, permitted industries, stormwater inflow, laundry graywater, and food wastes, as listed in Table 2-2. Strategies were identified based on similar programs conducted by Palo Alto for sources and strategies used by other communities for the identified sources. Because dentists are thought of as a commercial business source, methods that were previously used for other commercial sources, including outreach or permitting, were identified by Palo Alto. In addition, other communities had developed BMP for dentists that were available for use by the RWQCP program. Improper thermometer disposal is largely a residential source, so outreach to the general public with assistance from local businesses (pharmacies) was the identified strategy.

Type of Source	Controllability (high------------low)	Information Needs
Dentists	---X---------------------	
Household Products		
Thermometers	------X-------------------	
Contact Lens Solutions	------X-------------------	
Other Products	------------?-----------	What other household products contain mercury?
Permitted Industries		
Mercury-containing Reagents	-X-----------------------	
Mercury-containing Equipment	-X-----------------------	
Unidentified Sources	------------?------------	What are the unidentified sources?
Laundry		
Soil	----------------------X-	
Chemicals	------------?-----------	What chemicals or parts used in clothing manufacture contain mercury?
Graywater	---------------X---------	
Food Waste		
Food	----------------------X-	
Garbage Disposal	----------X--------------	
Stormwater Inflow		
Motor Vehicles	---------------------X---	
Other Sources	------------?-----------	How does mercury get into the water supply? Are there controllable sources of mercury in industrial stormwater runoff?
Human Waste	----------------------X-	
Water Supply	------------?-----------	How does mercury get into the water supply?
Unknown Sources	------------?------------	What are the unidentified sources?
? indicates that more information is needed about the source to make an assessment of its controllability.		

Figure 2-1. Controllability of Mercury Sources

Water Environment Research Foundation

Table 2-1. Loading Contributions from Controllable Mercury Sources

Potentially controllable sources	Load from Source (lbs./yr.)	Percent of Total Load (23 lbs./ yr.)
Dentists	2.1	9%
Household Products		
Thermometers	1.2	5%
Contact Lens Solutions	0.7	3%
Permitted Industries		
Hospitals	0.95	4%
Laboratories	0.22	1%
Storm Water Inflow	0.73	3%
Laundry		
Residential	2.6	11%
Commercial Laundries	0.028	0.10%
Food Waste	0.18	0.80%

Table 2-2. Mercury Source Control Strategies

Identified Sources	Source Control Strategy
Dentists	Business Outreach with BMP
	Regulate Dentists
Household Products	
Thermometers	Clean Bay Pharmacy Recognition Program
Contact Lens Solutions	Public Education
	Business Outreach
Permitted Industries	
Hospitals	Business Outreach
	Sewer Line Cleaning
Laboratories	Business Outreach
	Sewer Line Cleaning
Stormwater Inflow	Regional Strategies
Laundry	
Residential	Promote Graywater Systems
Commercial Laundries	Promote Graywater Systems
Food Waste	Public Education

2.1.4   Evaluate and Prioritize Strategies

The next step is to determine which strategies are likely to be most effective in achieving an agency's goals. Strategies are prioritized by determining the potential effectiveness of each control strategy and the cost to implement the strategy. The effectiveness of the source control strategies can be estimated on the basis of the level of participation expected and the maximum load reduction that may be achieved by the strategy. The effectiveness is then compared to the cost to implement the strategy. The effectiveness is determined as a product of the participation factor

and the load factor. Costs are based on previous experiences of the agency whenever possible. How these factors are determined and how this process was applied in Palo Alto is discussed in the following section. Although this process is not an exact science, it is useful as part of this planning process.

2.1.4.1 Participation Factor

Ideally, implementation of a control strategy would result in the elimination of the source it was designed to address. In reality, only a certain percentage of the people and procedures addressed by the control strategy will be changed. The participation factor estimates the amount of participation that can be achieved for a given control strategy. Because limited data on participation levels are available, these participation factors are considered to be rough estimates. Participation factors used in the Palo Alto study are described in this section. Whenever possible, estimates from previous efforts in the Palo Alto area are used. In general, participation factors are based on results from the first year of a program. Only a little information is available for participation changes over the longer term.

Public education and outreach programs can be expected to have a percentage of effectiveness between 5% and 20%. Outreach efforts in Seattle, Wash., resulted in behavior changes in 6% to 13% of the people surveyed (King County LHWMP, 1996). In Palo Alto, the average return rate for car wash coupons mailed to residents as an outreach measure was 10% in 1995 and 9% in 1996 (Palo Alto RWQCP, 1997). Because previous outreach efforts in Palo Alto resulted in an approximately 10% participation rate, this percentage is used as the participation factor for most public education programs. In cases where the program involves a more complicated message and/or clear alternative behaviors or products are not available, a 5% participation factor is used. A higher level of participation was assigned if the outreach effort was combined with a Clean Bay Business Program (a business recognition program) because the participants may also help promote the program.

Participation in business outreach programs is a function of how many businesses can be reached, the number of businesses reached that are willing to cooperate, and the businesses' share of the market. Most of the businesses addressed by business outreach programs for Palo Alto represent permitted industries in the RWQCP service area. Historically, RWQCP has been successful at identifying nonpermitted businesses for outreach in its service area. Therefore, it was assumed that RWQCP could contact 100% of the businesses in its service area. The cooperation rate can range from 30% to 100% depending on the difficulty of the program, the size of the community, number of businesses involved, and the presence of incentives. For example, Palo Alto has already contacted pharmacies to participate in the Clean Bay Pharmacy Program for thermometers; all pharmacies that were contacted agreed to participate. In addition, a vehicle service facility program was implemented that received participation from 49% of the businesses; this figure increased to 88% participation after 5 years of the program.

For the purpose of these estimates, a participation rate of 50% was assumed for nonpermitted industries based on the experience of the vehicle service facilities. Palo Alto only has five hospitals within its service area. Many of these hospitals had already implemented BMPs in association with previous outreach efforts. Only one hospital was reported to be less proactive in its pollution prevention efforts. Therefore, the business outreach participation factor for hospitals was assumed to be 80%.

Graywater management systems are expected to have a relatively low participation rate because of the cost of the systems and any retrofits that may have to be done to accommodate the technology.

Water Environment Research Foundation

For source control strategies outside a municipality's jurisdiction, an agency may decide to contribute to a regional or national effort to control pollutant source. This effort may involve working with other nearby agencies to produce regional outreach materials or working with a national task force to require reformulation of a commercial product. The participation rate for a regional/national strategy to reduce mercury levels in vehicle emissions was difficult to estimate because of lack of information about who would be involved in implementing this strategy and its technical feasibility. Because a significant part of the program would probably involve educating regional and national entities on the connection between mercury in fuel and stormwater quality, the strategy was assumed to have the same participation rate as a difficult-to-implement public education campaign (5%).

2.1.4.2 Loading Factor

The loading factor is the amount of pollutant load reduction from a source that could be expected if there was 100% participation. The loading factor varies depending on the sources that the strategy addresses. Loading factors are determined by estimating the amount of mercury coming from individual sources within a category. For example, sources of mercury from hospitals include mercury-containing equipment, mercury solutions, and mercury present in the sewer lines. Each control strategy is then examined to determine the individual sources that it addressed. Business outreach and public education strategies are assumed to address all individual sources.

In Palo Alto, for example, all programs related to thermometers and contact lens solutions have a loading factor of 100% because control strategies aimed at these sources would effectively eliminate the source. In the case of dentists, it was determined that a maximum of 90% of the mercury from dental amalgam could be removed using current technologies.

2.1.4.3 Effectiveness

The loading and participation factors are multiplied together to determine an estimated effectiveness associated with each control strategy. The determination of effectiveness by Palo Alto is shown in Table 2-3 for each control strategy.

Table 2-3. Effectiveness of Mercury Source Control Strategies

Identified sources	Source Control Strategy	Participation Factor	Loading Factor	Effectiveness Rating
Dentists	Business Outreach	50%	90%	45%
	Regulate Dentists	80%	90%	72%
Household Products				
Thermometers	Clean Bay Pharmacy	20%	100%	20%
Contact Lens Solutions	Public Education	10%	100%	10%
	Business Outreach	30%	100%	30%
Permitted Industries				
Hospitals	Business Outreach	80%	100%	80%
	Sewer Line Cleaning	40%	30%	12%
Laboratories	Business Outreach	70%	100%	70%
	Sewer Line Cleaning	40%	20%	8%
Storm Water Inflow	Regional Strategies	5%	60%	3%
Laundry				
Residential	Graywater Systems	2%	100%	2%
Commercial Laundries	Graywater Systems	40%	100%	40%
Food Waste	Public Education	5%	100%	5%

2.1.4.4 Cost Analysis

An overall cost analysis helps assess the ease of implementation of each strategy in addition to helping to determine if resources are available for that strategy. The costs of each strategy are evaluated based on the time requirements of staff as well as the direct costs of producing materials and outside contracts. Similar to the effectiveness factor, costs used for this step are typically rough estimates that are used for planning purposes. For Palo Alto, the cost to regulate dentists is assumed to be much higher than the cost to regulate other business categories. This is based on the experiences of other communities who have worked with dentists. The cost to implement strategies associated with permitted industries is relatively low because there is only a small additional cost associated with a new activity for a group targeted by an existing effective agency program.

2.1.4.5 Prioritization

To prioritize strategies, effectiveness factors are used to determine estimated load reductions, which are then compared to the expected costs to implement the strategies. The most cost-effective strategies are then chosen.

Estimated effectiveness, potential load reductions, and relative costs (that is, high, moderate, and low) for the different source control strategies for Palo Alto are shown in Table 2-4. The sources with the highest estimated influent load contributions were dentists and residential laundry graywater. The strategy available to address graywater, however, was determined to have a low potential effectiveness. Regulating dentists was determined to be reasonably effective, but extremely costly. On the other hand, an outreach approach for dentists was estimated to be reasonable with respect to cost and significant with respect to potential loading reductions. Similarly, potentially significant loading reductions and low cost were associated with programs targeting the permitted industries. Strategies addressing household products containing mercury were also determined to be cost effective.

Table 2-4. Prioritization of Mercury Sources

Identified Sources	Source Control Strategy	Effectiveness Rating	Reduction in lbs/year	Cost to Implement Strategy
Dentists	Business Outreach	45%	0.9	Moderate
	Regulate Dentists	72%	0.6(1)	Very High
Household Products				
Thermometers	Clean Bay Pharmacy	20%	0.2	Moderate
Contact Lens Solutions	Public Education	10%	0.07	Moderate
	Business Outreach	30%	0.2	Moderate
Permitted Industries				
Hospitals	Business Outreach	80%	0.8	Low
	Sewer Line Cleaning	12%	0.1	Low
Laboratories	Business Outreach	70%	0.2	Low
	Sewer Line Cleaning	8%	0.02	Low
Storm Water Inflow	Regional Strategies	3%	0.02	High
Laundry				
Residential	Graywater Systems	2%	0.05	Very High
Commercial Laundries	Graywater Systems	40%	0.011	Moderate
Food Waste	Public Education	5%	0.009	Moderate
Total Estimated Load Reduction			3.2	

(1) additional load reduction over an outreach-only approach.

Strategies given the highest priority with respect to implementation were outreach to dentists, public outreach regarding thermometers and contact lenses, development of a business recognition program for pharmacies, and working with permitted hospitals and laboratories.

2.1.5 Set a Goal

The final step prior to implementing a program is to identify a reference condition or goal to be achieved. This goal is the desired outcome to resolving the issue identified in Step 1. The goal may be developed at any point prior to implementing a program as long as adequate information is available to set the goal. How the goal is set will vary. The goal may be defined as the reference condition represented by the environmental condition prior to human impact. The goal may be based on a concentration level that allows an agency to meet a permit limit. Goals may also be set for intermediate stages to environmental improvement such as achieving 100% compliance with a regulatory program or a defined participation rate for a voluntary program. Once estimated effectiveness and potential load reductions are set, they may serve as program goals.

For Palo Alto, a reference condition for mercury or a goal would be a level in the environment that has no adverse impacts. This is a value that is not clearly defined. However, as part of its analysis, Palo Alto determined the total annual influent load (23 lb/yr). In addition, the total loading from identified sources was estimated to be 8.7 lb or a little more than a third of the total influent loading. Based on the estimated effectiveness of each strategy, the total loading reduction that was thought to be achievable if all strategies were implemented was 3.2 lb. If only the highest priority strategies were implemented, potential annual loading reductions were estimated at 2.3 lb. This analysis helps set a reasonable goal for the mercury pollution prevention program.

2.1.6 Implement a Program

Once control strategies have been prioritized, they are implemented based on available resources and staff time. Strategies that are determined to be most effective with respect to estimated loading reductions should be implemented unless they are cost prohibitive. In addition, strategies that are easy and inexpensive to implement should be considered even if they are only expected to be moderately effective with respect to load reduction. Incorporating effectiveness measures is an important element to be considered when initiating the chosen program.

The strategies Palo Alto chose to implement included the following:

- Business outreach to dentists;
- Clean Bay Pharmacy (recognition and public education) Program for thermometers;
- Public education and business outreach for contact lens solutions; and
- Outreach and sewer line cleaning demonstration project for a hospital or laboratory.

One program element was the thermometer program, in which Palo Alto initiated a Clean Bay Business Program for pharmacies to help reduce the use of mercury thermometers by residents (Moran, 1998). A pharmacy can become a Clean Bay Business by accepting thermometer rebate coupons and carrying educational materials on the hazards of mercury thermometers. The Clean Bay Pharmacy Program is accompanied by public outreach to make residents aware of the program. Residents who turn in a mercury thermometer to RWQCP receive a coupon for $2.50 which can be used toward the purchase of a nonmercury thermometer or another product at a Clean Bay Pharmacy. This offer was communicated through utility bill inserts and newspaper articles.

2.1.7 Evaluate Program Effectiveness

Effectiveness measurement is carried out before, during, and after a program is conducted. Different tools may be used at each of these points depending on the type of program, the audience, and other factors that will be discussed further in Chapter 3. Evaluation tools should be selected and used so that they measure the aspect of the program that is of most interest to the agency.

Palo Alto tracked thermometer turn-in rates to assess the overall success of their program as well as which types of outreach were most successful. In 1998, RWQCP received approximately 34 lb of mercury as household hazardous waste. Approximately 332 people brought in 741 thermometers. In addition, approximately 31 lb of bulk mercury was collected. While not all of this mercury would have ended up in the sanitary sewer, the total collected exceeds RWQCP's annual influent load of 23 lb.

Requests for coupons were used as a tool to track residential response to the program and the effectiveness of advertising methods. Palo Alto tracked the number of people responding to the coupon offer and the number of thermometers turned in as a result. These statistics were then compared to the timing of articles and bill inserts. Elements of the outreach program itself were developed in a way that simplified evaluation of the program's impact.

Figure 2-2 compares the thermometer turn-in rate to outreach efforts. A bill insert describing the rebate program was mailed in the middle of February. In addition, newspaper articles were published in March, May, and September. The thermometer turn-in rate remained high through the spring, but dropped off in the summer. Another increase in the amount of thermometers turned in occurred in September, which corresponded with the September newspaper article and ad.
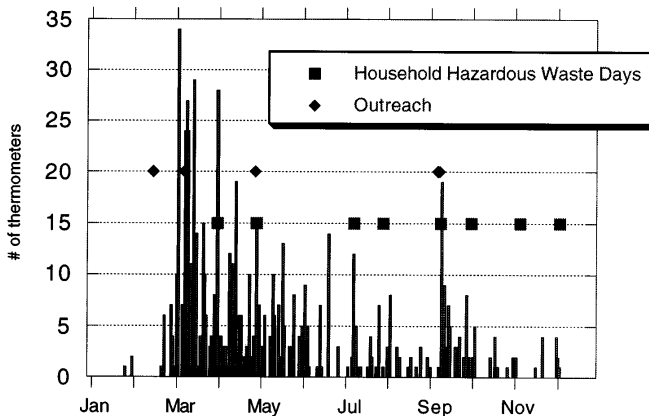
Figure 2-2. Palo Alto Thermometer Turn-In Rates

2.1.8 Modify the Program

Based on the results of the evaluation, decisions can be made on the future direction of the program. Evaluation may determine that a strategy is effective and should be used again.

Pogram results should be compared to the reference condition established at the beginning of the program to determine progress. As mentioned in Step 5 in the previous section, Palo Alto determined that the loading contribution from mercury sources that could be identified was 8.7 lb. Using the participation and loading factors, the estimated reduction that could realistically be achieved by implementing all the identified strategies was 3.2 lb. The estimated reduction that could be achieved for the implemented strategies was 2.3 lb.

These estimates along with program results can be used to guide Palo Alto's program in the future. Reductions from the implemented strategies can be compared to 2.3 lb to determine how effective the chosen strategies were. These numbers also set realistic expectations for the agency's program. RWQCP only has a small portion of the loading within its direct control, which may mean it will direct future efforts to working with entities with broader areas of control. On the other hand, RWQCP may choose to focus future work on identifying more of the unidentified sources of mercury.

Other information and decision points will come from analyzing the results of effectiveness measurement. For example, Palo Alto found that utility bill inserts were an effective way to offer the incentive to turn in thermometers. Evaluation may determine that the load reduction goal was achieved, indicating that the agency must decide whether it is appropriate to move on to other sources to achieve additional reductions or to other pollutant issues that are more pressing. It may even happen that the agency will determine that the reference condition or goal has been achieved. The agency would then need to decide whether to continue the program to ensure that the results continued or to begin focusing on other issues.

2.2   Evaluation of an Existing Program

In a situation where a program is ongoing or was not developed using the process described in the previous section, effectiveness measurement may still be accomplished. This section contains suggestions for incorporating evaluation into a program that is already in operation.

The first step is to determine what information is desired or what type of assessment is needed. Do environmental impacts need to be determined? Should participation and compliance rates or behavior changes resulting from a program be determined? An evaluation tool would then be selected based on the type of information needed.

The next step is to identify what type of information is available that can be used for evaluation. Monitoring data that were collected for another purpose can be assessed with respect to changes in average concentrations, maximum concentrations, or the number of permits exceeding limits. Telephone records, or logs, may exist that can be reviewed to determine if any telephone calls are in response to an outreach program. Information may be available on the number of individuals participating in a workshop or the number of businesses participating in a recognition program. These types of existing information may be used to assess a program's impact.

Another approach is to determine what is available that can be turned into an evaluation tool. For an outreach program, a distinctive logo or unique advertisement may have been used. A survey could be conducted to determine if these items and associated messages were memorable.

When annual work plans are under development for an existing project, opportunities to incorporate evaluation should be considered. Delta Diablo Sanitation District in California has an exhibit on pollution prevention that is displayed at an annual local festival. An element that was incorporated into this event was conducting an awareness survey. The survey is distributed at Delta Diablo Sanitation District's booth and completed surveys are entered in a raffle to win a gift certificate (Kobayashi, 1998).

It may also be possible to review an existing program's development and compare it to the steps of the framework process described here. This analysis may be used to identify available information for evaluation. The analysis may also be used to identify available opportunities to modify the program to establish base line information, set a goal, and incorporate effectiveness measurement.

Water Environment
Research Foundation

CHAPTER 3.0

Effectiveness Measurement Tools

Several agencies contacted for this report have developed innovative approaches to effectiveness measurement. These agencies have been able to demonstrate the impact their projects have had by using these tools. In this chapter, several tools are described along with examples of how they are used, followed by a discussion of how program effectiveness is measured in related fields.

Tools that can be used to assess source control programs include surveys, group feedback, pilot studies, environmental analysis, tracking responses, modeling, cost-benefit analysis, inspections/site visits, participation rates, and estimated load reductions. Each of these tools is described in the following sections.

3.1   Surveys

Surveys are often used to evaluate public education efforts. Types of surveys used include what is referred to in this report as quantitative surveys, targeted surveys, as well as variations of these such as telephone banking. A quantitative survey is a survey that is conducted on a randomly selected group of people (for example, random digit dialing telephone numbers). The group is large enough for the results to be statistically significant. In addition to questions designed to evaluate program elements, demographic data are also collected in an effort to see if there are groups with common characteristics that may serve as indicators for certain responses. Several programs have used this type of survey to assess awareness. A *targeted survey* refers to a survey of a group that is preselected in some way. For example, the San Francisco Water Pollution Prevention Program (WPPP) mails surveys to everyone that requests a specific educational material (Kehoe, 1999). These surveys are used to assess behavior change in response to the educational material. Another example of a type of survey is telephone banking. Telephone banking is similar to the random survey in that telephone numbers are selected randomly, but from a smaller geographic area that is targeted for a certain purpose. San Francisco has used this approach to test the impact of certain television commercials shown in a selected part of the city. While responses to targeted surveys and telephone banking are informative, they are not considered statistically significant.

An overview of how WPPP uses surveys to assess different aspects of their Public Education Program is described in the following section. A more detailed version of the case study is found in Appendix A.

3.1.1 Case Study: San Francisco Water Pollution Prevention Program, Public Education Program

The City and County of San Francisco Public Utilities Commission has a combined sewer and operates three water pollution control plants — Southeast, Oceanside, and Northpoint — for a service area of approximately 750,000 people (City and County of San Francisco, 1998). As part of its pretreatment program, San Francisco conducts the WPPP, which uses business marketing concepts to increase public awareness of water pollution and to change behaviors that contribute to water pollution. The three major components of the WPPP's public education program are community and neighborhood outreach, educational materials, and advertising and media coverage. The cornerstone of WPPP's educational materials are their residential guides: *Clean It!, Grow It!, Remodel It!, Fix It!,* and *Control It!* Each guide presents information on pollution prevention methods that stress ease and convenience for the user. At the same time, the guides highlight benefits of the desired behavior change without overwhelming the audience with "environmental information" that they may not understand or relate to.

The WPPP uses evaluation to determine which strategies work best to convey different types of messages and to measure the effectiveness of individual programs and products. The WPPP uses several methods to evaluate its program, matching the evaluation tool to the control strategy and the information desired. Evaluation methods used by WPPP include targeted mailed surveys, quantitative telephone surveys, and telephone banking. These methods and the strategies to which they are applied are described in the following section.

3.1.1.1 Mailed Surveys

Mailed surveys are used by the WPPP to assess increased knowledge and specific behavior changes. The usefulness of residential guides was evaluated by mailing surveys to people who requested the guides. Surveys are mailed approximately 6 months after the guides are shipped in order to assess awareness and behavior changes as a result of guide use. Return rates for surveys regarding *Remodel It!, Clean It!,* and *Grow It!* ranged from 6.5% to 13% (Kehoe, 1999). Survey responses indicated that 85% to 95% of the respondents found the information in each of the three guides helpful and felt that the guides had increased their overall awareness of water pollution.

3.1.1.2 Biannual Awareness Survey

Overall program assessment and behavior profiles are determined using a biannual scientific telephone survey that has been conducted since 1992. The survey consists of two parts. The first part asks basic questions about demographics, what products people use, how they dispose of these products, who they think contributes most to water pollution, and what they think the most effective methods of outreach are. These questions change only slightly from year to year. The second part of the survey is used to focus on particular issues, identify common characteristics of groups that use certain products, and find out what motivates groups to change their behavior. Products that typically are focused on in the second part of the survey are pesticides, motor oil, house cleaning products, and paint-related products. These products have been identified as residential sources of pollutants that may affect water quality.

Topics covered in the first part of the survey include the following:

♦ The types of toxic materials used by households,
♦ Awareness of environmental issues,
♦ Disposal practices,
♦ Perceived sources of water pollution, and
♦ Where people get information on environmental issues.

Water Environment
Research Foundation

The survey is also cross-tabulated to see if there are any demographic indicators of certain behaviors or perceptions. This information is used to focus outreach to the appropriate sectors of the population.

The second part of the biannual awareness survey is used to evaluate specific advertising campaigns. The results of some of these evaluations are described here.

In 1994 (Public Research Institute, 1994), the survey assessed the effectiveness of a street sign advertising campaign. As part of the campaign, 1,500 street signs were posted in English, Chinese, and Spanish warning the public about the hazards of pouring motor oil and other toxic material down the drain. Survey results indicated that 33% of the respondents saw the signs and that 25% of those who saw the signs would change their behavior as a result.

In 1996 (Public Research Institute, 1996), the survey evaluated safer housecleaning, oil recycling, and less-toxic gardening advertising campaigns. These campaigns were comprised of several outreach methods including street signs, bus advertisements, radio public service announcements or commercials, television public service announcements or commercials, newspaper stories, public transportation/bus system electronic signs, store promotions, and utility bill inserts. At least one campaign was remembered by 40% of survey participants. The street signs, television commercials, and utility bill inserts were found to be the most effective methods for these campaigns.

3.1.1.3 Telephone Banking

The WPPP uses telephone banking to assess levels of public awareness. While not a scientific analysis, telephone banking is still informative. For example, a television commercial's ability to convey a message and increase awareness was measured by using this tool. In April and May of 1998, an animated commercial was aired on cable television in the western part of San Francisco (Kehoe, 1999). At the end of the campaign, 777 residents of the targeted area were contacted by telephone. Approximately 13% of those contacted remembered the animated spot on gardening. The target audience for the commercials was gardeners over the age of 35. Of those who saw the spot, 73% were over 35 and 72% had a yard or garden. Therefore, the spots reached the key target audience.

3.2   Group Feedback

Evaluation can be conducted through group interactions that include focus groups, workshops, and advisory groups. It is important to carefully define the information being sought and to have a good facilitator for the group. It is also important to make sure that all relevant viewpoints are represented. Focus groups are used to assess attitudes toward issues, the results of which are used in the program planning process. Some examples of how focus groups have been used by the Contra Costa Clean Water Program (CCCWP) in California, the City of Davis, Calif., and the King County, Wash., Local Hazardous Waste Management Program (LHWMP) are discussed in this section.

The CCCWP conducts biannual focus groups to assess awareness, obtain feedback on specific campaigns, and gauge reactions to specific outreach materials (JD Franz Research, 1997). In addition to the quantitative awareness survey results, results from the focus groups are considered in future planning. In 1997, a guide on gardening practices as well as an advertising campaign targeting pesticide use and disposal were assessed by the focus groups. Residents were chosen from four geographic regions of Contra Costa County. Approximately 75% of the participants were chosen from people who had called to request a guide. A total of 47 people participated in the focus groups; each group consisted of 10 to 13 people.

In 1997, focus group results covered the following areas:

♦ **Level of behavioral change** — Focus group participants reported more environmentally positive approaches than previous groups. However, harmful practices that were reported included car washing with biodegradable soap, overapplication of fertilizer, use of spray-on wheel cleaners, and hosing down driveways. Stated barriers to behavior change included information, convenience, and cost.

♦ **Selection of environmentally certified contractors** — Group participants had not considered the environmental impact of contractors and thought that a certification would make the contractor more appealing. However, cost was also an important consideration.

♦ **Water quality awareness** — Group participants have a better understanding of the storm drain system and urban runoff and are more aware that residents/individuals are significant contributors to stormwater pollution. It was recommended that the CCCWP continue to build on the emerging awareness of these issues.

♦ **Gardening Guide** — In general, group participants felt that the guide had a usable layout and valuable content and was visually attractive. A cyclical promotion was suggested to capture new audiences, replenish old copies, and accommodate multiple program educational objectives.

♦ **Gardening Guide campaign** — Group participants discussed why they requested a guide and made suggestions to improve the advertising campaign including emphasizing the word free and simplifying some of the ads used. Although theater advertising did not appear to be effective, other advertising methods were remembered with equal frequency by the participants.

♦ **Other educational materials** — Other newspaper advertisements, radio and television commercials, and brochures were also presented to group participants. Certain topic areas of materials were of more interest (for example, a home repair/improvement guide). Some name changes as well as changes in the appearance of certain ads were suggested.

The City of Davis, Calif., used a workshop to help plan a strategy for educating residents about reduced pesticide use and integrated pest management (DeBra, 1998). A range of viewpoints was represented through City staff, local nurseries and hardware stores, a pest management company, residents, and members of the IPM (Integrated Pest Management) Task Force (a group promoting the use of IPM in the city). Assessment of what would work in the Davis community by this group resulted in the development of a program that identified a specific pollution problem (pesticide levels in local waterways) that had been traced to residential activities and outreach that worked well in the Davis community. Outreach included a slide at the local theater, master gardener workshops, events at the farmers market, a fan brochure distributed at the hardware stores and nurseries, and signs identifying the use of IPM principles in City landscaping projects. The overall program was well received by the Davis community, received positive publicity in the local newspaper, and resulted in renewed grant funding to continue the project.

Focus groups made up of property managers were conducted by King County Hazardous Waste Management in April and June of 1997 to measure awareness of hazardous waste issues (King County LHWMP, 1998). The groups included 27 property managers from small (less than three properties), medium (three to 10 properties), large (10 to 20 properties) and very large (greater than 20 properties) companies. Topics covered in the focus groups included types of hazardous materials on the property (primarily maintenance and facility materials rather than tenant-owned materials), approaches to monitoring the tenants' use of hazardous

materials, the decision-making capability of managers, and ways that King County could assist the managers. The group discussed the usefulness of existing King County programs for the business community. Onsite consultations, Industrial Materials Exchange, and a voucher incentive program were of interest to the small- and medium-sized firms, while the Business Waste Line was of interest to the larger property management firms.

3.3 Pilot Studies

An approach to assessing the potential effectiveness of a program is to conduct a pilot study with a small test group to identify strengths and weaknesses of the proposed program. The results of the pilot study can then be used to modify the program prior to full-scale implementation. An example of a study where a pilot program was used to test program effectiveness is the CCCWP High School Outreach Program.

The CCCWP conducted a pilot study at a local high school to determine effective ways of reaching high school students regarding car maintenance (Merritt Smith, 1999). Outreach materials that were developed included book covers with the school football schedule and key rings distributed at homecoming, advertisements in the school newspaper and the football booster club, an interview in the school newspaper, and involvement of the school's environmental club.

The high school pilot study was evaluated by conducting surveys before and after the outreach program at the study high school and at a control high school where no outreach was conducted. In addition, focus groups were conducted at both schools before the outreach campaign to assess high school students' attitudes regarding the environment and to gain a better understanding of their interests and activities. After the study, a focus group was conducted at the test school.

3.4 Environmental Analysis

It is often possible to directly measure environmental impacts of source control programs. This can be done using environmental indicators such as water quality analysis, toxicity testing, and bioassessment. One challenge associated with environmental analysis is the ability to connect the environmental improvement to the source control program under evaluation. The quality of wastewater effluent, for example, is the result of contributions from a variety of sources. Attributing a change in a pollutant's concentration to one particular source or activity is not always possible.

For example, Western Lake Superior Sanitary District (WLSSD) in Minnesota has been working to reduce mercury loadings in an effort to meet a National Pollutant Discharge Elimination System permit effluent limit of 0.03 μg/L (Tuominem, 1999). Sources that have been targeted as part of this effort include treatment plant operations, permitted industries, the commercial sector (that is, dentists, hospitals, and industrial laundries), and the general public. As a result, mercury levels in WLSSD's influent, effluent, and sludge have decreased substantially since 1990, as shown in Table 3-1.

Table 3-1. WLSSD Mercury Levels

Year	Average Influent Concentration (µg/L)	Average Effluent Concentration (µg/L)	Average Sludge Concentration (mg/L)
1990	1.18	0.335	3.8
1993	0.41	0.041	2.1
1995	0.25	0.059	1.3
1998	0.18	0.012	0.87

Initial reductions came at the end of 1990 as a result of WLSSD segregating its scrubber water and treating it separately from sludge. Pollution prevention efforts targeting permitted industries were responsible for the reductions seen after 1993. In 1995, WLSSD began to focus on commercial sources and the general public; as a result, mercury levels have continued to drop. However, because several sources were addressed by commercial and general public source control efforts, it has been difficult to determine contributions of individual sources to the observed reductions. In addition, WLSSD has observed a general trend toward increased awareness of mercury in the environment resulting in the decreased use of mercury-containing products. This increased awareness is probably a result of other outreach efforts in addition to those conducted by WLSSD.

It is possible to attribute environmental improvements to a particular pollution prevention effort if one source accounts for the major portion of a pollutant's loading. Examples in which improvements in effluent water quality could be linked to a specific source control program of the Palo Alto Regional Water Quality Control Plant (RWQCP) and the Novato Sanitary District (both in California) are discussed in the remainder of this section.

Prohibiting silver discharges from photoprocessors has effectively reduced silver levels in wastewater. Palo Alto RWQCP instituted its silver program in 1992 (Palo Alto RWQCP, 1994). Source identification studies determined that more than 75% of the RWQCP's influent silver originated from approximately 350 relatively small commercial businesses. Palo Alto's sewer ordinance required these facilities to either haul spent fixer offsite for recycling or recover the silver onsite and obtain a permit for the discharge of treated water to the sanitary sewer. As a result of the silver program, silver concentrations discharged to the San Francisco Bay by the RWQCP decreased from 14 µg/L in 1989 to 0.6 µg/L in 1993.

The Novato Sanitary District was able to reduce its copper effluent loadings by working with its water purveyor, Sonoma County Water Agency (SCWA), to implement pH adjustment of the water supply (Selfridge, 1996). The pH of the water supply was approximately 7.5 prior to SCWA's implementation of corrosion control through pH adjustment in September of 1995. Adjustment of pH to 8.5 resulted in a dramatic reduction in copper loadings. Influent copper loadings were reduced by 55%, with influent copper concentration decreasing from 140 µg/L prior to pH control in 1995 to 57 µg/L in 1996. Effluent copper loadings decreased from an average of 29 µg/L in 1995 to 12 µg/L in 1996.

Another approach to using monitoring results to assess program effectiveness is to conduct sampling at a business's discharge point. This approach is used when the impact of one source may not be apparent in a plant's influent or effluent, at a stormwater outfall, or in a receiving waterbody. The West County Wastewater District (Calif.) used this approach to assess its vehicle service program (Ng, 1998) and the Union Sanitary District (Calif.) used this approach to assess its printers program (Slama, 1998). In each case, dramatic reductions were seen in the dischargers' pollutant levels, as described in the following sections.

Water Environment
Research Foundation

3.4.1 Case Study: West County Wastewater District Vehicle Service Facility Program

West County Wastewater District operates a treatment plant with an average dry weather flow of 7.2 Mgal/d and a service area population of 85,000. The pretreatment program has a staff of two and an annual budget of $106,000 for both staff time and laboratory use. Approximately 45% of the budget is allocated for pollution prevention activities. The program works with five permitted industries. In addition to the permit program, West County works with 46 vehicle service facilities through a voluntary program. Approximately half (22) of the facilities are zero-discharge facilities. While the 24 businesses that do have wastewater discharges are not permitted, they must comply with local limits through a discharge ordinance. West County distributes best management practices (BMP) and an information binder to each vehicle service facility. Facilities are sampled at their discharge sump at least once a year for copper, mercury, lead, and zinc. If levels exceed local limits, then resampling is conducted at the facility's expense. To prevent resampling, the facilities implement BMP and conduct regular sump maintenance.

West County has seen dramatic decreases in metals concentrations from year to year. Table 3-2 shows average metals concentrations and the number of local limits that are exceeded for vehicle service facility samples taken between 1995 and 1998.

Table 3-2. West County Vehicle Service Program Results

Year	1995	1996	1997	1998	Change in Average Concentration	
					95-98	97-98
Number of Samples	14	32	59	33		
Number of Facilities	8	13	23	22		
Cu Average Conc. (µg/L)	5.1	0.92	0.316	0.142	97%	55%
No. of Local Limit Exceedances	2	1	0	0		
Hg Average Conc. (µg/L)	0.0012	0.0005	0.0003	0.0002	80%	31%
No. of Local Limit Exceedances	0	0	0	0		
Pb Average Conc. (µg/L)	9.8	0.85	0.20	0.073	99%	64%
No. of Local Limit Exceedances	6	2	2	0		
Zn Average Conc. (µg/L)	19.9	3.91	1.15	0.544	97%	53%
No. of Local Limit Exceedances	8	6	1	0		

3.4.2 Case Study: Union Sanitary District Pollution Prevention Program for Printers

Union Sanitary District operates a 25 Mgal/d wastewater treatment plant in Union City, Calif. The pretreatment program regulates approximately 55 significant industrial users and permits 20 additional businesses as minor dischargers. The program has a staff of 12 full-time (that is, 40 hours per week) employees, approximately 2.5 of which work on pollution prevention. In addition to pretreatment, Union Sanitary District conducts the Urban Runoff Program for the City of Fremont, Calif. One element of the city's pollution prevention program is regulation of commercial users including radiator repair shops, printers, automotive machine shops, and commercial car washes. Another element is the public outreach and education program, which includes a popular school outreach program.

The Union Sanitary District measures effectiveness of its programs using one or more of the following criteria, as applicable:

♦ Was there a measurable reduction in pollutant concentration/mass in the plant influent, effluent, or sludge?
♦ Was there a measurable reduction in pollutant concentration/mass in discharges from targeted facilities?

◆ Was there a high percentage of facilities in a targeted group participating in a voluntary, regulatory, or education program?

◆ Was there a measurable increase in awareness as a result of a public education campaign?

In 1994, Union Sanitary District printers were required to implement BMP (Union Sanitary District, 1995). A District-produced BMP guidance manual was distributed to all printers. The shops were required to submit a certification statement regarding BMP implementation. The District worked particularly closely with printers who used water-based flexographic inks because their discharges tend to have relatively high metals concentrations.

Print shops were sampled before and after the pollution prevention program was implemented. Printers are re-inspected periodically to make sure that they are still in compliance. Table 3-3 shows copper and silver discharge concentrations for selected printers before and after implementation of the pollution prevention program.

Table 3-3. Union Sanitary District Printers' Program Results

Printer	Cu Concentrations (mg/L)				Ag Concentrations (mg/L)			
	Average before P2	Max-imum before P2	Average after P2	Max-imum after P2	Average before P2	Max-imum before P2	Average after P2	Max-imum after P2
Flexographer 1	23.5	46	1.2	1.6	0.29	0.82	<0.06	<0.06
Printer 1	0.41	0.91	<0.1	<0.1	0.42	0.72	<0.06	<0.06
Flexographer 2	8.9	40	1	2.1	<0.06	<0.06	<0.06	<0.06
Flexographer 3	0.15	0.24	0.21	0.31	1.05	1.7	0.06	0.06
All Sampled Printers	5.7	46	1.1	2.1	0.39	1.7	<0.06	0.06

Average concentrations of copper were reduced 0.15 mg/L to 23.5 mg/L before the program to less than 0.1 mg/L to 1.2 mg/L after the program. For flexographic printers, maximum concentrations ranged from 40 mg/L to 46 mg/L before the program and 1.6 mg/L to 2.1 mg/L after the program.

3.5 Tracking Responses

Effectiveness may be measured by tracking responses to a source control strategy. An advertising campaign may include a telephone number to call to obtain a brochure on the topic. Tracking the number of telephone calls is one measure of the effectiveness of the advertising campaign. Education regarding the proper disposal of household hazardous waste may be tracked by recording the amount of certain materials turned into a household hazardous waste collection facility. Including coupons in advertising campaigns and tracking the number of coupons redeemed is another approach. Using this tool, however, requires that the tracked item be built into the program from the outset. If a brochure is being distributed, a returnable survey card or a telephone number should be included; preparations should be made to track the responses as they come in.

In addition to tracking direct responses to outreach efforts, changes may occur that indirectly result from an outreach campaign. These changes can also be tracked. An example of this is the decrease in complaints regarding illegal disposal of hazardous materials as people respond to an education campaign by changing their behavior. On the other hand, an increase in reporting of illegal disposal may also be a positive response to an outreach campaign as

people become more aware of environmental issues. Therefore, some effort should be put into understanding why a report is made in order to use this type of tracking as an effectiveness measure.

The San Francisco WPPP tracks telephone calls requesting their residential guides to assess different approaches to advertising guides (bill inserts and media coverage) (Kehoe, 1999). Inserts are purposely designed to be colorful and attractive. Inserts that include a telephone number to call for a guide are placed in 165,000 utility bills. Newspaper articles covering the topics of the guides also include a telephone number to call to request a guide. The WPPP has found that bill inserts are effective for advertising educational materials. In the 4 years that the WPPP has been producing its residential guides, it has received 20,000 calls requesting the guides as a result of the bill inserts. Out of 165,000 bill inserts mailed, requests have ranged from 4,000 to 7,000 calls per guide. In addition, newspaper articles (as opposed to paid newspaper advertising) have resulted in approximately 200 calls per article requesting the guides.

An overview of how Palo Alto used car wash coupon redemption to track program effectiveness as well as the effectiveness of different outreach methods is presented in the following case study (see Appendix A for a more detailed description).

3.5.1 Case Study: Palo Alto RWQCP Car Wash Coupons

One element of the Palo Alto RWQCP pollution prevention program is the Clean Bay Business Program targeting vehicle service facilities. Strategies used to get businesses to comply/participate in the program include onsite visits, positive incentives (Clean Bay Business recognition), and enforcement when necessary. One of the ways that the RWQCP publicizes the Clean Bay Business Program is to offer discount coupons to be redeemed at car washes that qualify as Clean Bay Businesses (Moran, 1998). The effectiveness of the car wash coupons is evaluated with respect to the number of coupons returned and the method of distribution that resulted in the most coupons being returned. This evaluation is accomplished by using different colored coupons for different methods of distribution and keeping track of how many coupons were distributed using each method and how many coupons of each color are returned.

During the summer of 1998, staff from the RWQCP distributed a total of 6,100 car wash coupons to a variety of locations (Palo Alto RWQCP, 1998). An additional 24,000 coupons were distributed as a newspaper advertisement through the *Mountain View Voice*; an additional 30,000 coupons were distributed to Palo Alto residents by means of a utility bill insert. In 1998, 2,671 coupons were used.

Since 1994, the distribution locations that have achieved the highest return rate are oil change services, automobile parts stores, and government employee paychecks. Other distribution methods that are used include utility bill inserts; counters at community centers, libraries, and city hall; and local corporation employee paychecks. Although these methods do not have the highest return rates, they are still employed because they reach residents and help increase their awareness of stormwater pollution. Distribution methods such as placing coupons on cars parked at shopping malls and hand-delivering coupons to residences were tried in previous years, but were discontinued because they were labor intensive and did not generate high coupon return rates.

The annual budget for the vehicle service facility program is approximately $50,000, of which approximately $20,000 is for site visits and sampling. The car wash publicity program is

one element of the vehicle service facility program. Tracking car wash coupons involves time — "a few hours per year" — to keep records and compile responses. In 1998, 2,671 coupons, which are $2 each, were redeemed for a total expense of $5,342.

3.6   Tracking Sales

A variation on tracking responses is to use changes in sales patterns to assess the effectiveness of source control programs. There are different approaches to using this tool, from buying sales data for a geographic area to asking individual stores to track or estimate their sales. How sales data are used will depend on what stage of a program is being evaluated. The information may be used during or after a project to assess progress or it may be used as part of the planning process. In this section, efforts to use product sales to measure effectiveness are described for King County and the San Francisco Bay area.

The King County LHWMP purchased supermarket sales data for the Seattle/Tacoma, Wash., market to track purchases of hazardous household products and alternatives (Dickey, 1995). Quarterly sales data were tracked over a 3-year period in an attempt to determine base line parameters and the effect of hazardous waste education programs. Some trends in sales patterns were noted over the 3-year period, including a strong increase in less-toxic pest control products within the last year of the study. However, there was no clear link between sales patterns and individual education programs. It was also noted in the study that purchasing this data was expensive.

In the San Francisco Bay area, the Central Contra Costa Sanitary District and Palo Alto RWQCP cosponsored a project to partner with hardware stores to promote the use of IPM approaches for home and garden pest control (Tucker, 1999). In this project, tracking sales was used as a direct measure of the effectiveness of outreach being conducted at the individual stores. In addition to the development of fact sheets and other point-of-purchase materials, store employees received training regarding effective pest control alternatives to diazinon and chlorpyrifos that they could recommend to customers. These stores then compared sales of diazinon, chlorpyrifos, and the less-toxic alternatives before and after the test project. In two of the stores, sales of pest control products were impacted by unusual weather patterns. One of these stores noted a decrease in sales of all but one of the chlorpyrifos and diazinon products. Although this store noted an increase in sales of several less-toxic products, it also noted a decrease in sales of other less-toxic products. The second store noted decreases in all pesticide sales, with a 50% decrease in chlorpyrifos, diazinon, and malathion sales, a 25% decrease in less-toxic product sales, and a 13% drop in pesticide sales overall. The third store observed a decrease in sales of all but one diazinon and chlorpyrifos product (20% to 50%), and a 17% increase in overall sales of less-toxic products. Overall, these results were interpreted to mean that training of store personnel could be effective in encouraging people to try alternative pest control products. Therefore, the project was expanded in its second year to include several other San Francisco Bay area hardware stores and garden centers. Tracking of product sales is being used again in the second year of the project to assess its ongoing effectiveness.

3.7   Modeling

Data can be compiled and used to develop models to predict program effectiveness. Two models — one based on demographic data and one based on water quality data — are described in this section.

Water Environment Research Foundation

The University of California at Berkeley, Department of Agricultural and Resource Economics, conducted a study with a predictability model to correlate yard ownership and the use of chemicals associated with landscaping with residential sociodemographics (WERF, 1998). There is widespread evidence of pesticides in creeks and other surface waters throughout the San Francisco Bay area. Yet, based on several factors, the study determined that up to 55.5% of San Francisco Bay area households were using and/or disposing of pesticides in a manner that might make the quality of groundwater, surface runoff, and soil worse than it is. People were found to be primarily concerned with the appearance of their yard, and less concerned with the underlying biological and physical processes associated with their landscaping. Choices related to pesticide use were also determined by constraints on information, time, and money (for example, people generally did not take the time to read labels or disposal instructions).

Conclusions of the study of the association of environmental behaviors with demographics include the following: the demands for yards and yard chemicals increase with family income; the impact of children on the use of chemicals depends on how vulnerable to exposure they are and how able they are to help with yard maintenance; and among those who keep yards, ownership (versus renting) does not affect decisions related to chemical use. The authors noted that the predictability model would be of value as a marketing tool to policymakers who regulate the use of yard chemicals and to sellers of pesticides and fertilizers.

The County and City of Sacramento, Calif., and the Cities of Folsom and Galt (both in California) developed a model to predict stormwater program effectiveness (Larry Walker Associates, 1996). The cities jointly developed an analysis technique using specific statistics and modeling to assess trends and long-term effectiveness of the Sacramento Comprehensive Stormwater Management Program. The database was compiled from samples collected at three urban runoff monitoring locations during 11 storm events. Constituents included in the analysis were arsenic, cadmium, chromium, copper, iron, lead, zinc, ammonia, biochemical oxygen demand, coliform bacteria, hardness, nitrate and nitrite, oil and grease, phosphorus, organic carbon, total dissolved solids, total suspended solids, and cyanide. The mathematical model predicted changes in stormwater quality as a result of program implementation ranging from 15% to 40% over a 20-year period.

3.8   Cost-Benefit Analysis

When assessing the usefulness of a source control program, it is important to consider the cost of the program versus the improvement realized as a result of the program. An example of a program assessed from this perspective comes from the Los Angeles County Stormwater Program.

From a pilot workshop conducted by Los Angeles County for the auto repair industry in November 1998, it was determined that the costs of conducting such workshops for specific businesses were too prohibitive (that is, $20,000 for 50 to 60 people in attendance for this particular workshop) (Harris, 1999). Program efforts are now being directed toward "piggybacking" the stormwater education plan onto existing programs. For example, in 1998 the Department of Health Services (DHS) began requiring restaurant managers to be certified in sanitation practices. Precertification training programs now include stormwater-related BMP, and reach 50,000 restaurant employees/managers annually. The cost to include stormwater BMP into DHS's program was nominal.

Another example of a cost-effective program is the composting program conducted by the Montgomery County, Md., Department of Environmental Protection (DEP) (Environmental Hazards Management Institute, 1997). This program is described in the following section.

3.8.1   Montgomery County Department of Environmental Protection Composting Program

Montgomery County is a large suburban county in Maryland. Montgomery County DEP administers a highly successful, award-winning home composting education program for its more than 750,000 residents. A 1994 ban on the disposal of yard debris induced the County to launch a massive, public education campaign encouraging residents to "grasscycle" (that is, recycle their grass and leaves) and home compost.

A program was developed whose two major elements were an advertising campaign and an educational curriculum for schools. To develop the program, the County conducted market research and worked with educators. The County conducted a survey of more than 1,100 residents to determine their perspectives on grasscycling and composting. Results of these surveys indicated that a primary obstacle to grasscycling was residents' concerns about the health of their lawns. In addition, before implementing educational curricula, DEP worked with community educators to develop a successful curriculum with wide community support.

The County contracted an advertising agency to assist in development of the educational campaign to encourage residents to grasscycle and home compost. The campaign was based on results of the initial market research and used a variety of multimedia tools to educate the public including television, radio and print advertising, videos, movie theater advertisements, public relations and media appearances, direct mail, master composters, workshops, cable television gardening programs, written materials, Web sites, and compost bin distribution. The County also contracted the advertising agency to assist in developing the educational curricula for schools.

Montgomery County implemented VermiLab, an extensive, hands-on, multidisciplinary program for children in kindergarten to 12th grade that teaches students about home composting with worm boxes. Educational curricula are in place in 110 county schools and large-scale vermicomposting is ongoing at 12 of these schools.

The program has been evaluated based on changes in attitudes, the number of people grasscycling, the number of people composting, the number of compost bins purchased, reduction in volume of yard debris requiring municipal management, and the cost of the outreach program. The success of the Montgomery County program is due in large part to initial surveys of community composting attitudes and behavior.

The initial market survey revealed that nearly 54% of Montgomery County residents believed that leaving grass clippings on the lawn would damage the lawn, and 14% believed clippings left on the lawn caused thatch. Consequently, educating residents that grasscycling is actually beneficial to lawn health became the major focus of the subsequent outreach campaign. Follow-up surveys indicated that the number of residents who believed that grass clippings were unhealthy for lawns dropped to less than 16%; only 6% of residents associated clippings with thatch.

In 1995, a survey indicated that 70% of the residents grasscycled and 60% composted. Approximately 22,000 home compost bins were sold to residents and, after 2 years, more than 90% of the bins were still in use.

Water Environment
Research Foundation

Since implementing the grasscycling advertisingcampaign, the County has realized an annual reduction of 50,000 tons or more of yard debris requiring municipal management.

The total cost of the public education campaign was $360,000 in 1994 and $232,000 in 1995. Despite the seemingly high cost of the program, it has been cost effective for the County in terms of large financial savings in avoided yard debris collection, processing, and facility and related capital project costs. In addition, the County did not need to expand its central composting facility, saving $2.5 million and an additional $1 million in avoided annual processing costs.

3.9   Inspections/Site Visits

When working with a clearly defined group, such as a single business category, conducting site visits to determine if the desired practices are being implemented can be used as a direct measure of behavior change. Although this tactic is labor intensive, it serves other useful purposes such as building rapport with businesses, helping to ensure compliance with regulations, and providing technical assistance specifically geared to the individual business.

An overview of the King County Onsite Consultation Team Program, a program that uses site visits to assess its business assistance program, is presented in the following section. A more detailed description of this case study is presented in Appendix A.

3.9.1   Case Study: Onsite Consultation Team Program, LHWMP in King County

One element of the King County LHWMP is its business program, which includes field inspection teams, a hazards telephone line, an industrial materials exchange, and incentive programs. One of the field inspection teams is the Onsite Consultation Team.

The Onsite Consultation Team has set goals associated with waste reduction and improving compliance (King County Department of Natural Resources, 1998). The program has a staff of six and an annual budget of $327,000. The staff provides technical and regulatory compliance assistance to conditionally exempt small quantity generators at their request or upon referral from other agency programs. The staff helps business owners develop practical hazardous waste management programs, reduce their generated waste, and comply with regulations. Of the 40,000 to 60,000 small quantity generators of hazardous waste in King County that could use the program, approximately 400 express an interest in site visits each year.

Since 1992, cumulative data from follow-up inspections indicate that the program has reduced hazardous waste generation by 2.75 million pounds and caused 9.37 million pounds of hazardous waste to be diverted from improper disposal. In addition, 68% of businesses showed improvements in compliance with program BMP (King County Department of Natural Resources, 1997).

The Onsite Consultation Team Program effectiveness is assessed annually based on established objectives for performance, environmental impact, and behavior change (Wadell, 1998). Assessments have resulted in modifications to improve the program over the years. During the first year of the program, outreach language was changed based on low turnout and feedback. Since then, participation has increased. Initially, data were collected on every detail of the site visits. Later, some of the data were determined to be unnecessary as collection of this information was eliminating saving substantial staff time.

3.10   Participation Rates

An important element of determining the effectiveness or potential effectiveness of a source control program is identifying what portion of the targeted audience changes its behavior or participates in a project. This factor can be measured by counting the number of businesses in compliance with a regulatory program. Behavior change may also be determined by counting the number of businesses that qualify for a business recognition or certification program or by counting the number of people attending a workshop. Some examples of participation rates include the number of businesses participating in recognition programs such as EnviroStars, a recognition program in King County, or Businesses for the Bay, a recognition program in the Chesapeake Bay area in Maryland. After 3 years, EnviroStars had 150 participating businesses (Tomchick, 1999). Businesses for the Bay had 250 participants in 1998, and set a goal of having 75% of the eligible businesses in the watershed participating by 2000 (Mecum, 1998).

One element of Palo Alto's pollution prevention program is the Clean Bay Business Program, which targets vehicle service facilities (Brosseau, 1997). For a vehicle service facility to qualify as a Clean Bay Business, it must comply with the City's ordinance and implement a variety of BMP. Strategies used to get businesses to comply/participate in the program include onsite visits, positive incentives (Clean Bay Business recognition), and, when necessary, enforcement. Because enforcement is an option with this program, participation rates are somewhat higher than with programs that rely exclusively on positive incentives. Compliance with each of the 15 ordinance requirements (each requirement is a BMP) has been tracked since 1992. A business qualifies as a Clean Bay Business if it is in complete compliance on its first annual inspection (that is, no follow-up inspection required) and has no discharge limit violations. In the first year, 156 businesses (48%) were in complete compliance and 131 businesses (40%) qualified as Clean Bay Businesses. By 1997, all 303 vehicle service shops were in complete compliance and 21 out of 23 fleet maintenance facilities were in complete compliance. In addition, 277 businesses (92%) qualified as Clean Bay Businesses.

In 1996, the Bay Area Stormwater Management Agencies Association (BASMAA) established an incentive-based program for mobile cleaners in the San Francisco Bay area to address discharges from their cleaning operations (Larry Walker Associates, 1999). The initial focus of this program was on surface cleaning. Surface cleaners are mobile businesses that wash surfaces such as parking areas, sidewalks, streets, and building exteriors. BASMAA's program discourages surface cleaners from discharging certain types of wastewater to a storm drain, and instead recommends that, for most situations, the wastewater be discharged to a sanitary sewer. With respect to surface cleaning activities, wastewater must be discharged to a sanitary sewer if soap is used or if paint is removed by the cleaning process. Wastewater may be discharged to a storm drain if no paint or soap is involved and the surface is first cleaned using dry clean-up methods.

It was estimated that approximately 125 surface cleaning companies were in operation in the San Francisco Bay area. In 1996, 166 individual surface cleaners from these companies received recognition through BASMAA's program as "Recognized Cleaners" who conduct their operations using recommended BMP. In 1997, 75 to 80 cleaners applied for recertification in this program.

The Wisconsin Nutrient Management Program is an example of a study that relied on farmer participation (Wisconsin Department of Natural Resources, 1999). This case study is presented in the following section.

3.10.1 Case Study: Wisconsin Department of Agriculture Nutrient Management Pilot Project

Urban and rural nonpoint sources are the greatest cause of Wisconsin's water quality problems. Through a partnership between state agencies, county land conservation departments, and private-sector crop consultants, Wisconsin piloted a unique project to address rural nonpoint sources and promote better use of manure and other crop nutrients. The 1995 Nutrient Management Pilot Project involved almost 160,000 ac of cropland in watershed projects in 22 counties. Private crop consultants took soil tests and prepared nutrient management plans for individual farmers. In return, farmers received a $6 paycheck from the state for every acre they planned.

A nutrient management plan suggests how a landowner can use organic (mostly manure) and commercial fertilizer together most effectively while avoiding overapplication of nutrients that often leads to pollution of nearby streams and lakes. The pilot project represented a new approach to reaching farmers and improving water quality by using the private sector (that is, crop consultants), an entity from which studies show farmers receive much of their information.

"The public sector has been searching for ways to establish working relationships with the private sector in efforts to control nonpoint source pollution," says Don Baloun, a Wisconsin Department of Natural Resources agriculture implementation specialist who helped spearhead the project. "The pilot represents one of the first successful achievements in this arena," he adds.

The nutrient management plans cost just under $1 million statewide. Roughly 550 farmers participated in the plans. Implementation of the plans ranged from approximately 50% in some counties to 100% in others.

Funding provided to the Lake Mendota Priority Watershed allowed nutrient management plans to be developed for 90 producers. The land area that was 30,691 ac represented 36% of the cropland acres in the watershed. Preplan application rates of phosphorous were estimated at 1.13 million pounds in the watershed. After plans were prepared and implemented, phosphorous applications dropped to roughly 0.46 million pounds. This constitutes a 60% reduction in applied nutrients and a savings of $200,000 in fertilizer costs.

3.11   Estimated Load Reductions

Estimating load reductions is a tool that is used during the planning process to help determine the potential effectiveness of a source control strategy. The process to determine an estimated load reduction is based on estimating the portion of the audience that will implement the desired behavior and the portion of the loading that can be addressed by the chosen control strategy. This process was described in Chapter 2 as it was applied to the development of the Palo Alto Mercury Pollution Prevention Plan. Another example of how estimated load reductions may be used is the Sacramento Stormwater Program's Copper Control Measure Plan (Larry Walker Associates, 1998). An overview of this case study is presented in the following section, with a more detailed description presented in Appendix A.

3.11.1 Case Study: Sacramento Stormwater Program, Copper Control Measure Plan

The Sacramento Stormwater Program used estimated load reductions to develop a plan to address sources of copper in stormwater. The sources of copper in stormwater identified by

Sacramento include pesticide use, atmospheric deposition, tap water, automotive brake pad wear, metal recyclers, tire wear, metal finishers, cooling towers, construction site runoff, automobile dismantlers, airports, swimming pools, and food product manufacturers.

In addition to these sources, the source identification study evaluated parking lots and highways. Parking lots and highways are not considered to be sources, rather, stormwater conveyances or pathways for pollutants from vehicle-related sources (that is, brake pads and tires). These pathways may serve as points of control for vehicle-related sources.

Loading contributions were determined for each of these sources based on information obtained from the literature and other agencies and from data collected by Sacramento. It was determined that more information was needed to assess pesticide use, atmospheric deposition, and tap water as sources of copper in stormwater. Source control strategies were identified for the other sources, as listed in Table 3-4. To prioritize these sources, Sacramento used many of the same participation and loading factors that were used by Palo Alto, as discussed in Chapter 2, but also developed estimates for some additional strategies associated with their project. Participation and loading factors and resulting effectiveness for selected strategies are shown in Table 3-4, along with estimated load reductions from these sources. Sacramento also assessed the copper sources with respect to controllability, applicability to other pollutants of concern, and cost.

Table 3-4. Estimated Load Reduction for Sacramento Copper Control Measures

Source	Max. Load (lb/yr)	Control Strategy	Audience Participation Factor	Load Factor	Effectiveness Rating	Estimated Reduction (lb/yr)
Vehicle related	5900	Work w/ Air Board -ride sharing	5%	50%	3%	148
Brake pad wear	5900	Brake Pad Partnership	30%	80%	24%	1416
Parking lots	2900	Employee education	10%	80%	8%	232
		Structural BMPs	5%	50%	3%	73
		Inlet cleaning	5%	80%	4%	116
		Street Sweeping	80%	3%	2%	70
		Stencils/ signs	10%	10%	1%	29
		Parking redesign	5%	5%	0%	7
Streets and highways	1168	Narrower residential streets	5%	3%	0%	2
Metal recyclers	135	Existing Programs, lead BMPs	80%	80%	64%	86
Tire wear	1003	Public Education on tire maintenance	10%	25%	3%	25
Cooling towers	75	Redirect to Sanitary sewer	50%	100%	50%	38
Metal finishers	5	Industrial BMPs	50%	80%	40%	2
Construction site runoff	605	Existing programs	80%	80%	64%	387
Auto dismantlers	156	Existing programs, lead BMPs	80%	90%	72%	112

Based on this assessment, the following conclusions were drawn with respect to controlling copper sources:

1. The following control measures were identified as the most effective based on the estimated reductions shown in Table 3-4 (potential reductions for these measures were greater than 100 lb/yr):

   ♦ Participating in Brake Pad Partnership;
   ♦ Continuing New Development Management Program requirements for permanent onsite BMP (includes combined effects of multiple structural controls);
   ♦ Conducting employee education with respect to parking lot maintenance;

♦ Conducting parking lot inlet cleaning; and
♦ Controlling construction site runoff and runoff from automobile dismantlers.

2. While incomplete information is available with respect to costs of implementing control measures, the least expensive measures appear to be supporting existing industrial and construction site programs and modifying existing outreach materials for prohibiting nonstormwater discharges from cooling towers.

3. The cost of participating in the Brake Pad Partnership may vary, but potential reductions as a result of this control measure are an order of magnitude higher than the estimated reductions for any other control measure.

As a result of the analysis, Sacramento determined that the following control measures or information-gathering activities should be pursued:

♦ Conduct monitoring for pesticides, rainfall, and tap water;
♦ Participate in the Brake Pad Partnership;
♦ Continue to implement existing programs and/or develop new programs targeting parking lots;
♦ Cooperate with California Air Resources Board with respect to Ride Share and Reduced Vehicle Use outreach programs; and
♦ Continue and expand, where appropriate, existing construction site and industrial program control measures.

3.12   Effectiveness Measurement in Related Fields

Other fields in which assessment is important are advertising and education. In both of these fields, surveys are used extensively for evaluation. Other tools that are used include focus groups and direct observation. Approaches used by market researchers to assess social marketing programs and by educators to assess science education programs are discussed in the following section.

3.12.1 Advertising/Social Marketing

Commercial advertising and marketing techniques can be used to influence social behavior to benefit the target audience and society (Weinrich, 1999a). This approach is called social marketing and was first applied to public health issues. More recently, the approach has been used to address environmental issues. Commercial marketing focuses on a consumer's needs and desires. A marketing program contains the elements of product, price, place, and promotion. Social marketing has the same focus and program elements. However, each program element takes on a slightly different meaning when applied to social issues instead of consumer products. The social marketing product is not necessarily a physical item, rather, it may also be a practice, a service, or an intangible idea. In this context, *price* refers to what the consumer must do to obtain the product and is not necessarily monetary. The term may also represent the time, effort, or inconvenience required. *Place* refers to how the product reaches the customer. For a behavior change, *place* will refer to how the information is provided to the consumer including mass media, doctors' offices, shopping malls, or in-home demonstrations. *Promotion* refers to the integrated use of advertising, public relations, promotions, media advocacy, personal selling, or entertainment vehicles. Research and evaluation are critical to the social marketing process. Evaluation tools used during planning, development, implementation, and assessment of a social marketing program are discussed here (Weinreich, 1999b).

Research during the planning stage is used to characterize the target audience and to determine the program's direction. Tools used during planning include surveys and focus groups, both of which have previously been discussed. Other approaches to obtaining information during the planning phase are the in-depth interview, review of existing information, and "gatekeeper" audits. In some cases, expressing opinions as part of a group may be inhibiting. Individual interviews using the same types of questions as a focus group allows the respondents more privacy. Similar to a focus group, this approach is qualitative.

Review of existing information has previously been discussed in the context of developing base lines and obtaining information about pollutant sources and control strategies. In a similar vein, information review for marketing is used to obtain existing information about the social issue, previous attempts to address the issue, the probable target audience, and potential media vehicles. Information review is also used to obtain information about the competing "product," which, for a social issue, would be nonadoption of the desired behavior. Marketing databases are a source of information used in social marketing. Major marketing surveys are conducted that may provide insight into the target audience's attitudes and behaviors pertaining to a particular topic. Marketing surveys may also provide useful information about other habits of audiences that will help identify ways to successfully reach the audience. Marketing databases compile survey data and provide extensive information on demographics, consumer buying habits, and the use of media. Marketing databases may also provide information about groups that influence the target audience (that is, parents, other relatives, doctors, policymakers, and so on).

A gatekeeper audit is another tool used during planning. Gatekeepers are individuals who control the content and flow of information that reaches the target audience. Examples of gatekeepers include editors, producers, pubic service directors, and other influential people in organizations. A survey to determine gatekeeper awareness and attitude toward an issue allows planning on how to effectively persuade them to deliver the desired message.

The second phase of a social marketing program is development of the message and materials. In addition to using focus groups and in-depth interviews, the effectiveness of the approach chosen is measured by obtaining feedback from the consumer using central site interviews and forced exposure. Focus groups and in-depth interviews were discussed with respect to the planning phase. Central site interviews are conducted at a location commonly visited by the target audience (for example, a shopping mall). The interviewer selects and screens subjects who appear to fit the target audience, and the selected subjects are then asked to answer a questionnaire after exposure to the social marketing messages or materials. This method is not statistically valid, but can reach a large number of people quickly and inexpensively. Forced exposure, a more expensive approach, involves recruitment of people to a central location to preview and evaluate new television programs. During the session, respondents see a television program along with advertisements for various products and services. Respondents are then asked to remember and write down the products for which they saw advertisements and the associated messages.

Other tools used during the development phase to evaluate materials are readability testing and professional review. The readability of printed text may be assessed using standard formulas that analyze sentence length and the number of polysyllabic words. This assessment is used to determine if the developed materials are at a reading level that is appropriate for the targeted audience. In addition to evaluation by a target audience, it can also be helpful to have professionals who are knowledgeable about the topic review materials. Professional reviewers can evaluate the materials for appropriateness, clarity, design, and comprehensiveness.

During the implementation phase, the program is put into place and monitoring is conducted to ensure that the program stays on target. Success can be determined through media monitoring and analysis, evaluation of program activities, and issues monitoring. Media monitoring involves determining how often the program is mentioned in television, radio, or print news reports and analyzing the accuracy and desirability of the messages in the media coverage. *Activity evaluation* refers to tracking responses including the number of people attending events, responses to direct mail, or calls to a toll-free number. Issue monitoring refers to tracking developments in the field and events that have strategic implications with respect to the campaign topic. This information can be accessed through news and information databases. Issue monitoring using these databases is expensive and may only be applicable to campaigns conducted at the state or national level.

Once completed, the program is evaluated during the assessment phase. Evaluation of the program is divided into three categories: process, outcome, and impact evaluation. Process evaluation determines how successful the program was at reaching the target audience. Outcome evaluation determines if the desired behavior was adopted by the people exposed to the message. Impact evaluation determines if performing the behavior resulted in the desired change.

Process evaluation takes place at specific intervals, such as after 6 months or annually. To achieve process evaluation, follow-up surveys are conducted and the results are compared to initial baseline surveys. These follow-up surveys are also used to assess outcome. Impact is assessed by evaluating overall trends and determining if change can be attributed to the social marketing program. One approach to determining a direct cause and effect relationship is to conduct the program in one community and compare the results to those seen in a control community where the program was not conducted.

3.12.2 Educators

For traditional, formal education, evaluation is an integral part of the process as students are tested and receive grades reflecting their performance. School programs are assessed based on the percentage of children performing at, above, or below grade level. In addition to testing, educators also use surveys and other tools to assess their programs. These alternative tools are particularly useful when evaluating informal education such as Denver's Volunteer-Led Investigations of Neighborhood Ecology, or the VINE Program (Holweg, 1997).

The VINE Program provides science activities that engage young children with hands-on experiences investigating the natural environments at their school and in their neighborhoods. Lay naturalists, both adults and teenagers, are used to involve the students in the inquiry and to assist in their collection of and reflection on experimental and observational data. The VINE Program originated in Denver in the 1980s and was subsequently established in 11 other cities across the country. Educators and organizations wishing to start a program in their city receive a program manual, training videos, model curricula, and materials such as magnifying lenses to be used in outdoor investigations.

The VINE Program has been evaluated over the years through special studies and annual data collection. Evaluation tools used include existing data, new surveys, outside evaluators and observers, and activity log sheets. An important aspect of many of the evaluations is the comparison of results to a control group, either through comparison with national survey responses or assessment of a group with similar characteristics not participating in VINE activities. Aspects of the program that have been assessed and the evaluation tools used are listed in Table 3-5.

Table 3-5. Evaluation Tools

Program Aspect	Evaluation Tool(s) Used
The target audience	Registration records, demographic data collection
Whether the experience is new or different	Written adult surveys, open ended verbal questions to children in groups, checklists asked verbally
Volunteer leaders, teacher, parent, and student satisfaction	Written surveys
Adaptability/flexibility of the program	Observation by outside evaluator-case studies
Is the program being implemented as intended	Observation by outside evaluators-completing checklists
Program cost	Analysis of financial statements
Impact on students	For children - written survey with open ended questions; drawings; For adults - written survey
Influence on teachers and their classroom practices	Written surveys, pre-coded log sheets for teachers

VINE programs aim to provide their target audience with outdoor science experiences in their own neighborhoods that would not otherwise have been available to them. Two tools were used to determine if the VINE programs were achieving this goal. One was a questionnaire for adults and the other was the use of open-ended questions asked verbally of children in small groups. The process of asking children open-ended questions evolved over time. In early studies, an open-ended question was asked and the child's first answer was recorded as the response. Later studies used checklists and multiple questions. Other aspects of how the evaluation was conducted was the use of control groups, asking questions before and after participation in the program, and comparing VINE statistics to statistics available from the U.S. Department of Education. In the same setting, the same questions were asked of classes participating in VINE programs and classes not using the VINE programs. Questions about what science activities a child had done were asked prior to and following participation in five outdoor VINE investigations. Some survey questions were taken from the National Assessment of Educational Progress so that VINE results could be compared to the Department of Education's large national sample.

As previously noted, VINE programs are conducted by different organizations in several different cities. To determine how the VINE Program was adapted in different settings, an outside evaluator was used to observe the program at different sites, develop case studies, and draw conclusions based on observations regarding adaptability of the VINE Program. The results of this study found that the program was robust and flexible enough to be adapted to a variety of settings. Use of an outside evaluator was enthusiastically received by individual program leaders. The evaluation process was perceived as an integral part of program development that helped to mold their programs in a relatively unobtrusive way. The case studies and results from this study were used to promote the program. This study on adaptability proved to be instrumental in obtaining funding to start a new VINE Program in Baltimore. A drawback to this evaluation method was that the results were reported as a narrative and, therefore, were subjective in nature. A modification of this method would be to supplement the narrative with a matrix identifying elements that were common to all sites and elements that were unique to individual sites.

Outside evaluators were also used to assess whether the program was being implemented according to program guidelines at the different sites. For the evaluation, observers were

provided with checklists relating to the way the activities should be carried out. Outside observers, teachers, and adult volunteers actively involved with VINE were all used to carry out the evaluation. The checklist seemed to be easily used by all the evaluators. In addition to being useful in program evaluation, the checklist process has been useful in promoting a better understanding of the program by adults who are actively involved in VINE and shaping its future.

Exposure to the VINE Program typically involves participation in five to eight 1-hour sessions over the course of a school year. In order to determine if the limited exposure to the VINE program has an impact on the students participating in it, fifth graders were surveyed using written questionnaires with open-ended questions before and after participation in a VINE Program. Some survey questions were taken from the National Assessment of Educational Progress so that VINE results could be compared to national results. Adults were also surveyed for their impression of the children's interest in science. In addition to the questionnaires, fifth graders were asked to draw and label what they had seen living in their schoolyard. The purpose of this exercise was to assess what the children learned from VINE. Pre- and post-VINE drawings were assessed with respect to application of information learned in a VINE activity, organization or logical coherence of the picture, and the complexity or level of detail of the picture.

The effort to evaluate the program's impact on its participants used a large sample of students and was labor intensive. Focused preplanning could have made this effort less time-consuming. Assessment of the drawings could have been improved based on more recent work done by other researchers. For example, the drawing assessment would have been more insightful if it had been supplemented by student interviews and checklist assessments filled out by teachers. Even so, this evaluation was considered valuable and worth the time spent.

The impact of VINE programs on teachers was assessed by profiling the participating teachers and determining whether a particular VINE program influenced their teaching practices. Surveys were used and responses from teachers involving their students in VINE were compared to a control group of teachers. The survey results showed that the VINE teacher profile was not significantly different than a control teacher profile. Interesting findings were that more than 70% of the teachers thought that VINE activities were different than their regular science teaching and that the program influenced their science teaching. In addition, almost 60% of the teachers said they did not have specific training enabling them to teach science, and more than 75% of the teachers were interested in workshops to help improve their science teaching skills.

Based on these results, the VINE Follow-Through Project was developed to help teachers to build on VINE investigations in the classroom. The three-city project included summer institutes, teamwork sessions, and school-year team meetings. Each team consisted of five (or more) teachers, school district curriculum specialists, university faculty, local VINE program coordinators, and a facilitator/coordinator. To assess the influence of the project on classroom practices, the VINE Program was faced with the dilemma of documenting classroom practices without using expensive classroom observations. The solution was to ask the teachers to complete precoded log sheets documenting classroom activities. In addition to being less expensive than using observers, teacher logs provide data over a longer period of time. On the other hand, observations can provide a more complete objective picture of the classroom. Overall, teacher logs proved to be an effective, inexpensive alternative to classroom observations. Some improvements to this method would include having a coordinator to both encourage teachers to complete logs and to collect the logs from teachers, and having another nonteaching team member complete a few "corroborating logs" during classroom visits.

CHAPTER 4.0

CHOOSING THE BEST EFFECTIVENESS MEASUREMENT TOOL

One of the greatest challenges when measuring the impact of a source control program targeting commercial and residential activities is linking a measured improvement to a specific activity. For many issues, there are a variety of programs and activities that may have an influence on an individual's behavior. For example, several organizations in one area may be conducting outreach regarding pesticide use and disposal (that is, a local master gardener's program, household hazardous waste program, stormwater program, or even a local pest management company). Messages from each entity may be complementary or conflicting, and it may be hard to tell which effort caused a measured reduction in effluent toxicity. For one pollutant that has several sources in a community, it may also be hard to tell which source was the one that was reduced enough to result in a measurable decrease in the pollutant's effluent concentrations. Breaking the project down into smaller parts may help identify an effective way to measure the impact of a certain source control strategy. Some program components include:

♦ The environmental improvement phase (program implementation, increased awareness, behavior change, or environmental improvement);
♦ The project planning and development phase (before, during, or after conducting the project); and
♦ The target audience for the project (general public and commercial businesses).

Approaching projects from each of these perspectives is discussed in this chapter along with how this may affect which tools are selected to assess the program.

4.1 Which Stage Do You Want to Measure?

Tools vary in their applicability to the different components in the environmental improvement phase. Appropriate assessment tools will depend on whether the project goal was to achieve program implementation, increased awareness, behavior change, or environmental improvement.

4.1.1 Measuring Increased Awareness

Program implementation is best measured by tracking the number of activities conducted (for example, number of businesses inspected, number of workshops, and the number of brochures distributed) or by measuring participation rates (for example, number of brochures requested or number of people attending a workshop). Although assessment of program

implementation typically is straightforward, it is the one stage at which the impact of the program is not measured.

Increased awareness of the issues usually results from an educational outreach campaign. A campaign's impact is typically measured by a quantitative survey. Survey participants must be selected randomly to determine general awareness. Questions should be carefully crafted to assess the survey participant's knowledge rather than leading the participant to the obvious answer. Awareness surveys are conducted by several agencies, including the San Francisco Water Pollution Prevention Program (WPPP), as described in Chapter 3, and the Contra Costa Clean Water Program (CCCWP). An overview of how the CCCWP uses quantitative surveys to assess awareness as a result of their public education program is presented in the following section (Godbe Research & Analysis, 1998). A more detailed description of this case study is found in Appendix A.

4.1.1.1 Case Study: CCCWP Public Education Program

The CCCWP is the stormwater program for Contra Costa County, Calif. The population of CCCWP's service area is approximately one million. The CCCWP conducts the public education program to increase awareness of stormwater pollution and change polluting behaviors. Outreach messages have focused on reducing pesticide use and recycling used motor oil. Messages are promoted through television, radio, newsletters, the newspaper, bill inserts, the Internet, bus and subway placements, a billboard, and theater advertising. The gardening guide, *Grow It!*, was promoted through these media.

The CCCWP measures awareness of the overall program and collects information on attitudes and behavior through an annual public opinion survey. The CCCWP has used information from public opinion surveys to identify effective outreach methods and to help plan future public education activities. Quantitative survey results are considered along with the focus group results previously discussed when making decisions on future directions of the public outreach program.

Just like the quantitative surveys conducted by other programs, the survey is conducted by interviewing 400 adults living in Contra Costa County by telephone using random digit dialing. Questions asked are from the following areas:

- ♦ Awareness of environmental issues in general and with respect to water pollution in particular;
- ♦ Understanding of storm drain systems and who are significant contributors of water pollution;
- ♦ Which household products are commonly used (that is, motor oil, pesticides, and paints) and practices associated with the use and disposal of these products;
- ♦ Awareness of outreach messages regarding stormwater;
- ♦ Attitudes/willingness to change their behavior with respect to pollution generating practices; and
- ♦ Willingness to pay additional taxes to help prevent stormwater pollution.

Some conclusions and recommendations resulting from the 1998 public opinion survey include the following:

- ♦ Contra Costa County residents are not overwhelmingly concerned about water pollution. Therefore, education campaigns should focus on increasing the frequency that information is heard within the limits of the program's available budget.

W Water Environment Research Foundation

♦ While knowledge regarding the destination of the storm drain system has increased from 25% in 1994 to 37% in 1998, there is still a tremendous opportunity to educate residents about the storm drain system and the impacts of improper pollutant disposal. These efforts should target females, who are more than twice as likely as males to be uninformed about these issues.

♦ Information specifically designed to change environmentally harmful behavior should be targeted to high-risk groups that continue to inappropriately dispose of hazardous products. Survey results indicated that outreach regarding improper disposal should target non-Whites under the age of 40. Efforts to encourage recycling and composting should target younger, less-educated, and less-affluent residents. Similarly, certain behaviors were associated with geographic areas within the County, indicating that certain outreach efforts should target certain geographic areas.

4.1.2 Measuring Behavior Change and Environmental Improvement

Behavior change is best measured by a targeted survey with a preselected audience, such as the mailed surveys used by the San Francisco WPPP to assess their residential guides that were described in Chapter 3. Environmental impact is accomplished using environmental indicators. The City of Greenville, Texas, for example, used effluent toxicity to measure environmental improvement.

Greenville has a population of 23,000 and an average dry weather flow at its treatment plant of 3 Mgal/d (WERF, 1998). In 1991 and 1992, plant effluent failed six out of seven and 11 out of 12 toxicity tests, respectively. Diazinon was identified as the cause of the toxicity, and monitoring indicated that the diazinon was probably coming from residential sources. Diazinon levels in the city's effluent ranged from 0.1 µg/L to 0.2 µg/L.

In late 1992, Greenville implemented a public education program that discouraged residents from using diazinon, encouraged the use of integrated pest management practices, and recommended alternatives to pouring diazinon or even rinse water down the drain. Outreach methods included highway billboards, radio public service announcements, newspaper articles, school programs, and speakers for community groups.

Since 1993, Greenville has conducted toxicity testing monthly during the summer and quarterly in the winter. Toxicity failure occurred no more than once a year from 1993 to 1995, with no toxicity failures recorded through the middle of 1996. Since the public education program was implemented, diazinon levels in the city's effluent were mostly below the detection limit of 0.1 µg/L.

4.2   When Do You Want to Evaluate Your Program?

Evaluation can be used at each stage of program development and implementation. Appropriate assessment tools will depend on whether the project is in the planning stage, in progress, or completed. The King County, Wash., Local Hazardous Waste Management Program (LHWMP) uses evaluation extensively in its programs and has identified tools that can be used before, during, and after conducting a project (Frahm, 1994). King County uses evaluation before a project to test materials and ideas and to identify and gather information on the target audience. For this purpose, King County uses telephone or mail surveys, store intercepts, focus groups, and advisory groups. Evaluation is conducted during a project to monitor activities and change the project in response to feedback. Tools used include getting feedback/evaluations of workshops or other materials (for example, newsletters and

brochures) and tracking calls for information. Evaluation is conducted after a project to determine performance (that is, achieving initial objectives) and impact (for example, increased awareness, changes to behavior, and environment). Performance is evaluated using qualitative and quantitative measures such as the number of brochures distributed, workshop attendance, or achieving budgets and deadlines. Impact is measured using a variety of tools including surveys, sales data, disposal data, waste stream monitoring, or environmental monitoring. Examples of how agencies use these tools at different points in the process are described in the following section.

4.2.1   Evaluation When Planning a Project

There are several ways to use evaluation during the planning process. Evaluation before a project is used to test materials and ideas and to identify and gather information on the target audience. One approach to preproject evaluation is the estimated load reductions described in Chapter 2. Other approaches include telephone or mail surveys, store intercepts, focus groups, and advisory groups. Preproject evaluation can also include monitoring or surveys that are used to establish a base line condition. Programs that regularly use these approaches include the City and County of San Francisco and the Los Angeles County Stormwater Program.

In the 1998 San Francisco WPPP public awareness survey, questions were asked concerning attitudes and practices related to the use of pesticides and paints and awareness of water pollution (Public Research Institute, 1998). The results of the 1998 survey are being used to plan 1999 outreach campaigns. Major conclusions drawn include the following:

- ♦ Health is more important to people than the environment, money, or leisure time;
- ♦ Informational messages about the effects of toxic products on personal health or the health of family members are the most persuasive messages to use to cause people to change behavior with respect to gardening practices and pest control;
- ♦ Informational messages about latex paint being easier to clean up than oil paint are the most persuasive messages to use to encourage people to choose latex paint for their next painting project;
- ♦ *Water pollution* meant different things to different people, although most people said it meant contaminated drinking water or pollutants in the bay or ocean;
- ♦ When buying products most people look for information on price, but less than 20% look for information on safety;
- ♦ A sizable minority of survey participants do not think that disposal of toxics in drains poses a danger to the environment;
- ♦ Attitudes toward government sponsoring education are good; and
- ♦ Most people read a daily newspaper, have cable television, and listen to the radio during drive time, according to an assessment of media use.

The Los Angeles County Stormwater Program conducted a segmentation study of the general public to help plan their public education program (Los Angeles County, 1997). An overview of this study is presented in the following section, with a more detailed description found in Appendix A.

4.2.1.1 *Case Study: Los Angeles County Stormwater/Urban Runoff Public Education Program*

As part of the 1996 National Pollutant Discharge Elimination System (NPDES) permit for Los Angeles County, a comprehensive educational stormwater and urban runoff outreach approach was mandated to reach as many Los Angeles County residents as possible. The goals of the program are to measurably increase the knowledge of target audiences on the impacts of

stormwater pollution and measurably change the behavior of target audiences by encouraging appropriate solutions.

A precampaign segmentation study was conducted to prioritize audiences and activities to target those residents most likely to pollute. Several hundred people throughout Los Angeles County were interviewed by telephone and asked a series of questions designed to identify:

♦ Characteristics that allowed researchers to determine "segments" of the population (groups with common profiles);
♦ How much different segments of the population pollute stormwater and urban runoff (knowingly or unknowingly);
♦ How much of an effort it would take to motivate the different segments of the population to make changes that would clean up runoff pollution; and
♦ What the key motivating factors are for each segment.

This study identified target audiences who would also be the most likely to adopt behavioral changes and could be reached in a cost-effective manner. Based on the results of the segmentation study, the public outreach program was designed to reach:

♦ The general public identified as wanting "to do the right thing;"
♦ "Do-it-yourselfers;" and
♦ A harder-to-reach, younger, rebellious segment of the population that was found to be motivated by actions that would protect children or water sports areas.

The segmentation study indicated that the largest target audience, the segment of the general public that intends to do the right thing, gets most of its instructional information from mass media. Newspapers, radio, and billboards are used as the three key sources to disseminate program information. To a lesser degree, the outreach program also uses public service announcements, instructional materials, corporate and entertainment industry tie-ins, displays, community events, a speakers and experts bureau, and an existing hotline number.

The segmentation study, which cost approximately $100,000, was one of the most important components of Los Angeles County's 5-year public education plan. Nearly all strategies in the five-year plan were designed to target segments of the population that the study showed would produce the greatest results in terms of reducing pollution.

4.2.2   Evaluation During a Project

Evaluation is conducted during a project to monitor project activities and change the project in response to feedback. Tools used include getting feedback/evaluations of workshops or other materials (for example, newsletters and brochures), conducting site visits, and tracking calls for information. Tracking the amount of thermometers turned in was a tool used during the Palo Alto, Calif., mercury outreach campaign described in Chapter 3. After turn-in rates dropped over the summer, additional publicity through a newspaper article and an advertisement generated an increase in turn-in rates in September.

4.2.3   Evaluation After a Project

Evaluation is conducted after a project to determine performance (that is, achieving initial objectives) and impact (for example, increased awareness, changes in behavior, and environment). Performance is evaluated using qualitative and quantitative measures such as the number of brochures distributed, workshop attendance, or achieving budgets and deadlines. Impact is measured using a variety of tools including surveys, sales data, disposal data, waste

stream monitoring, or environmental monitoring. Based on previous experience, King County recommends measuring the impact of outreach and education efforts shortly after the project has been completed and again at a later time to see if the changes last. The Washington State Department of Ecology has developed a program to provide teachers with the background necessary to teach courses on watersheds and water pollution (Hunter, 1998). An assessment of this program was conducted at the end of the course and a year after the course was given as the case study presented in the following section.

4.2.3.1 Case Study: Washington State Department of Ecology Water Education for Teachers

The purpose of the National Project Water Education for Teachers (WET) is to provide teachers with effective hands-on activities that engage students in learning awareness, appreciation, knowledge, and stewardship for water. The project's focus on watersheds, pollution prevention, and water conservation integrates student learning in science, math, social studies, art, and language. The project was written by thousands of teachers and water resources professionals across the country and has attained the highest reviews for environmental education water resources materials.

The Washington State program was funded by a U.S. Environmental Protection Agency 319 grant for five priority watersheds ($52,200). With that infrastructure in place, 16 additional workshops were funded by local governments, school districts, and the U.S. Bureau of Reclamation. Facilitator training workshops were funded by Environmental Education & Training Partnership grants through The Watercourse at Montana State University. The Washington State Department of Fish and Wildlife contributed funding for travel and PROJECT WILD activity guides. Workshops have reached 746 teachers and more than 50,000 students. This evaluation deals with 14 workshops that reached 334 teachers in the five Washington priority watersheds (Washington State Department of Ecology, 1998).

The workshops were one and one-half day classes. The teachers' knowledge was tested at the beginning and end of the class. Before the workshop, 39% of the teachers scored As and Bs (graded on a standard scale) in watershed knowledge, compared to 73% after the workshop. In addition, at the workshop's completion all respondents stated that they planned to use Project WET in their teaching.

A survey conducted a year after the workshop showed that:

♦ Approximately 80% of teachers were using WET activities in their classroom.
♦ Approximately 60% had their students conduct watershed-related projects such as stream restoration, monitoring, clean-ups, storm drain stenciling, salmon raising, or community events.
♦ Some reported personal watershed protection actions like using less water at home, decreasing fertilizer use, fencing horses out of the creek, and preserving streamside vegetation.
♦ All of the respondents still rated the workshops as good or excellent. A focus group of GREEN teachers gave Project WET a resounding tribute as their best foundation curriculum for watershed understanding before students begin water quality monitoring or restoration projects in their community. Teachers also noted that parents were discussing water topics at teacher conferences and becoming more involved with projects.

The program's effectiveness was measured to improve the program, verify that program goals were met, and prove to program managers and sponsors that the program is worthwhile.

Water Environment
Research Foundation

It became clear that the WET program could serve teachers' needs even better by aligning the core activities of Project WET with the new state-required Essential Academic Learning Requirements. This realization has since been implemented.

As a result of evaluation, some program changes made include the following:

♦ A low level of understanding by the teachers (even after the class) that drinking water comes from groundwater indicated more time should be spent on clarifying that point and emphasizing the importance of groundwater protection.
♦ Results showed that elementary teachers needed a little more background on watersheds and water quality than secondary or adult-level teachers did. Future workshops for elementary school teachers will be more carefully structured to meet their needs with respect to additional basic knowledge.

4.3   Who is the Target Audience of Your Program?

Depending on the pollutant and its sources, target audiences will vary greatly. It is important to consider the audience when planning and conducting an evaluation. Most of the target audiences for pollution prevention programs will fall into the general categories of commercial businesses or the residential community. Other possible audiences may include agriculture and school programs.

4.3.1   Business Audience

Projects targeting businesses may address business activities of all kinds if the message is general or may focus on a specific business category associated with a certain pollutant issue. Recognition programs targeting businesses in general have been developed to encourage businesses to improve hazardous waste handling and disposal practices and to use pollution prevention. Assessment tools may include on-site visits, participation, or compliance rates. King County has developed several programs targeting businesses in general including the Onsite Consultation Program described in Chapter 3 and EnviroStars. An overview of assessment of the EnviroStars program based on participation rates is presented in the following section. A more detailed description of this case study is found in Appendix A.

4.3.1.1 Case Study: EnviroStars, King County LHWMP

EnviroStars is a business recognition program for hazardous waste prevention (King County LHWMP, 1998). The program's goals are:

♦ To use positive recognition as an incentive for small businesses to prevent hazardous waste generation and pollution,
♦ To provide examples for other businesses to model themselves after,
♦ To increase consumer awareness and influence purchasing decisions based on responsible environmental practices in King County businesses, and
♦ To provide a tool that field staff can use to bring about lasting waste prevention changes.

The program was introduced in 1995 and targets businesses in King County that generate small amounts of hazardous waste (that is, auto body and repair shops, printers, dry cleaners, machine shops, manufacturers, dentists, laboratories, and so on). There are an estimated 45,000 potential businesses in the target audience. In 1997, 92 site visits were conducted and 38 business became EnviroStars. Two business groups that were targeted were dental offices and automotive facilities. Outreach to each of these groups has been conducted through their industry

associations. Thirteen businesses of each group were recognized as EnviroStars in 1997. By early 1999, 38 EnviroStars (25% of the total) were dentists and 61 EnviroStars were vehicle service facilities (41% of the total). There were a total of 102 EnviroStars at the end of 1997 and 150 at the end of 1998.

With respect to targeting a specific business category, several municipalities have developed programs for vehicle service facilities, photoprocessors, and printers. Several factors influence how an agency can most successfully work with businesses, including the number of businesses involved, existing regulatory programs, participation in trade associations, and attitudes of the business category. Site visits and wastewater monitoring have been used effectively to assess programs targeting commercial businesses, including vehicle service facilities and printers. Examples of this type of assessment were presented in Chapter 3 for the West County Wastewater District Vehicle Service Facility Program and the Union Sanitary District Printers Program (both in California).

Dentists are an example of a business category that has been targeted with respect to mercury discharge reduction. Western Lake Superior Sanitary District (WLSSD) in Minnesota has developed a program targeting dentists that relies heavily on cooperation with the local dental society (WLSSD, 1999). Group feedback was an important assessment tool that was used throughout the project to modify and enhance the dental programs. An overview of how assessment has been used in this program is described in the following section, with a more detailed description presented in Appendix A.

4.3.1.2 Case Study: WLSSD Zero-Discharge Pilot Project — Dental Program

WLSSD is the largest wastewater treatment facility discharging into the Lake Superior watershed. The treatment plant has an average daily flow of 43 Mgal/d and serves a population of 130,000. WLSSD is working to meet a mercury effluent limit of 0.03 μg/L specified in their NPDES permit. WLSSD has embarked on a project with a goal of achieving zero discharge for mercury over the long term (WLSSD, 1998).

WLSSD developed their dental program by working with the local dental association. WLSSD staff approached the Northeast District Dental Society and suggested that they work together to raise awareness in the profession and keep mercury out of the wastewater. Cooperation between WLSSD staff and the dental society has been the key to this project's success. With assistance from the dental society, WLSSD staff produced a manual of best management practices, and they continue to work with the dental society to evaluate managing amalgam and educating the dental community.

Throughout this program, evaluation has been used to plan and make modifications. Evaluation during the planning process included conducting surveys, obtaining group feedback from the local dental society, and conducting base line monitoring of dental wastewater discharges. Evaluation during the project has included subsequent wastewater monitoring, waste audits, and tracking of mercury collected as a result of these programs. These approaches to evaluations and the resulting program modifications and enhancements are discussed here.

As part of the planning process, a survey was designed to determine practices of the dental profession with respect to waste generated in the every day operation of the office, with a specific emphasis on mercury/silver amalgams. Development of the survey was greatly enhanced by assistance from the Northeast District Dental Society. On the deadline of August 10, 1992, fifty-two dentists had responded for a return rate of 58%.

Water Environment
Research Foundation

In 1993, WLSSD staff sampled the wastewater discharge from a medical building housing several dental practices and found a mercury concentration of 35 ppb, which represented approximately 0.3 g of mercury discharged by each dentist each day (WLSSD, 1999). Subsequent monitoring of the same building in 1995 found the effluent mercury concentration reduced to 0.086 g of mercury per dentist per day. This reduction was attributed to the outreach program and changes in waste handling practices at the dental offices.

In 1995, WLSSD staff returned to the dentists to conduct waste audits. As a result of the mercury audits, the most important identified needs were to:

♦ Improve waste management practices for chair-side traps and vacuum pump traps,
♦ Improve the infrastructure for managing the mercury-containing waste, and
♦ Increase the amount of amalgam captured in the vacuum system in order to reduce the quantity of amalgam particles discharged to the sewer.

In order to address these needs, WLSSD presented its findings to local dental organizations and formed an environmental committee composed of WLSSD staff and representatives from the Northeast District Dental Society. Elements added to the dental program as a result of these more recent joint efforts include programs to increase recycling, conduct on-site training, produce additional educational materials, and evaluate amalgam separation units.

4.3.2   Residential Audiences

When working with the residential community, general awareness messages can target the whole community. For more specific issues, the general population can be broken down into groups with common characteristics. Gardeners are typically targeted by outreach campaigns to reduce the use and improper disposal of pesticides. Do-it-yourselfers are often targeted by used motor oil education campaigns. Assessment of the target audience is included in development of several outreach campaigns through focus groups, quantitative surveys, store intercepts, and workshops. King County's Natural Lawn Care Project is a good example of a program that targets a group within the residential community. An overview of this program and its assessment is presented in the following section, with a more detailed description found in Appendix A.

4.3.2.1 Case Study: King County Hazardous Waste Management Program Pesticide Awareness Program/Natural Lawn Care Project

In 1992 and 1994, King County conducted a hazardous waste survey that included questions on pesticide use (King County LHWMP, 1995). Survey results indicated that more people use pesticides on their lawn than anywhere else (for example, 57% in a 1994 survey). In 1993, it was estimated that pesticides accounted for 5% of the waste stream at local household hazardous waste collection sites, and 25% of the disposal cost (that is, more than $1 million). Therefore, an outreach campaign was launched to reduce residential pesticide use and future disposal costs. The targeted audience for these campaigns was suburban homeowners over 30 years of age with incomes of more than $50,000. This group was determined to be the highest pesticide user in the Seattle–King County area. Specific objectives of the program were to:

♦ Increase awareness regarding overuse of pesticides,
♦ Increase awareness of potential health effects of lawn care pesticides, and
♦ Encourage reduced use of pesticides.

Outreach strategies used from 1994 to 1996 included radio advertisements, advertisements on buses traveling in areas populated by the target audience, promotional announcements,

brochure distribution, and other assistance by local radio stations. To evaluate the advertising campaign, telephone surveys were conducted before and after the advertising campaign, "Hazards Line" calls were tracked, and surveys were mailed to people calling the Hazards Line.

The results of the before and after telephone surveys conducted between 1994 and 1996 measured the percentage of respondents who said they were likely to use pesticides or herbicides on their lawn during a particular year (King County LHWMP, 1996). In 1994, there was no change in the overall percentage of respondents from before the campaign to after the campaign who indicated they were likely to use pesticides. However, in the target income brackets, there was a decrease in the likelihood that respondents would use pesticides after the advertising campaign. In subsequent years, there was also a decrease seen after the advertising campaign. Recall of the advertisements after one month was also evaluated each year. Approximately 22% to 24% remembered the advertisements, with more people remembering the radio ads than the bus ads. The number of calls to the Hazards Line regarding pesticides ranged from 75 (in 1995) to 586 (in 1994).

Based on results from the 1994 to 1996 campaign, the program was changed to focus on lawn care in 1997 and 1998. The Natural Lawn Care Project aimed to reduce the use of pesticides and water and increase mulching and mowing. Outreach strategies used included radio advertisements, television advertisements (1998 only), door hanger brochures (1997 only), workshops, utility bill inserts, a toll-free telephone line, newspaper columns, gardening calendars, press releases, media events, and radio interviews.

Results of the Natural Lawn Care Project assessments indicate that the advertising campaigns have been effective in changing attitudes (King County LHWMP, 1998). In addition, the advertisements were memorable. In 1997, approximately 36% of people surveyed recalled the advertisements and approximately 25% recalled one or more specific messages that were used. During the Natural Lawn Care Project, focus group results from 1997 were used to develop messages and strategies for 1998, with an emphasis placed on the "how" and "why" of changing lawn care practices.

4.3.3   School Programs
Many outreach programs try to convey their environmental messages through school programs. The effectiveness of a program presented to students or teachers is assessed based on participation, an increase in knowledge, or behavior change. The King County Hazardous Waste Management Program conducts classroom presentations for students in grades four through 12 (Gensler, 1999). The assessment of this program is presented in the following section. Some assessment is conducted 6 months to a year later to determine if changes as a result of the program are long lasting.

4.3.3.1 *Case Study: King County Hazardous Waste Management Program, Household Hazardous Waste School Program*
Hazards on the Homefront, a classroom presentation for grades four through 12, is presented to a single classroom in a one-hour session. The program began in 1993 as a few classroom presentations and has gradually evolved to a larger program. Currently, approximately 235 presentations are made each school year. Through hands-on activities, experiments, games, problem solving, and discussion, students find out about common household hazardous waste products such as bug killers, automobile products, paints, and cleaners. Most students get to test safer alternatives from a Green Cleaning Kit, and teachers receive their own kit for classroom use. The high school lesson, specifically designed for grades nine through 12, takes students shopping as they make tough consumer decisions in a hands-on, hazardous waste

shopping game. All programs show how hazardous household products affect human and environmental health. Teachers frequently integrate this program into studies of water quality and water pollution, recycling and waste disposal, environmental and health issues, and chemistry as it relates to the community. Other elements of the school program include lesson materials, a teacher's guide and workshop, field trips, a traveling exhibit, programs for youth groups, and a teacher's Web site.

Classroom presentations are evaluated annually to determine if the presentations resulted in positive behavior changes. The school program aims to teach students recognition of words found on labels that signal a hazard, encourage students and their families to try safer products, and have students to bring new information home to their families. Surveys were mailed to teachers who participated in presentations in 1997 and 1998 at the end of the school year. The teachers distributed the surveys to the students to complete. Teachers were then responsible for collecting and returning the surveys to King County staff. In 1997, surveys were mailed to 190 teachers and 6,800 students. In 1998, surveys were mailed to 185 teachers and 6,500 students. Results of the surveys are shown in Table 4-1.

Table 4-1. School Program Evaluation

	1997	1998
Student response rate	47%	37%
Teacher response rate	62%	48%
Recognizing signal words (e.g. danger)	82%	87%
Students using Green recipe cards for cleaners at home	66%	66%
Behavior change other than making safer cleaners	Students: 82% Teachers: 97%	Students: 82% Teachers: 97%
Teachers use green cleaning kit	79%	57%
Teachers think program is important	86%	88%

In addition to this survey, a satisfaction survey is also conducted at the end of each presentation. King County staff has made few changes because the results of the satisfaction survey and behavior change survey have been positive. One change was made as a result of the drop in teachers using the Green Cleaning Kits in 1998. Instead of delivering the kits to teachers ahead of time (as was done in 1997), they are hand delivered by staff to provide a contact that will help reinforce the benefits of using the kits.

More information on this program and other King County programs can be found on their Web site at *http://www.metrokc.gov/hazwaste/*.

CHAPTER 5.0

PROCESS SUMMARY AND FINDINGS

In this chapter, procedures for developing a pollution prevention program and incorporating effectiveness measurement into the program are summarized. Effectiveness measurement tools and considerations when selecting a tool for a program are discussed based on case studies and other examples. In addition, findings and recommendations are presented.

5.1   Process Summary

The process used to develop a source control program and considerations at each step are summarized below.

1. ***Identify the issue.*** An effective source control program has a clearly defined issue. Define the issue by:

    ♦   Identifying a pollutant of concern or a waste stream and
    ♦   Establishing a base line by determining pollutant loading or waste stream volume.

2. ***Identify and assess sources****.* Sources may be identified through monitoring, agency records, or by reviewing the literature and other agency programs. Once sources are identified,

    ♦   Determine the significance of the source by estimating its contribution to the total pollutant loading or waste stream volume.
    ♦   Assess the source's controllability with respect to the agency's ability to work with the source. This will include several factors such as jurisdictional and political concerns.

3. ***Determine available control strategies.*** To identify possible control strategies for each source,

    ♦   Consider control strategies already in use by an agency that target similar sources,
    ♦   Review strategies used by other agencies for this source, and
    ♦   Brainstorm to come up with new ideas that would work in the service area.

4. ***Evaluate and prioritize control strategies.*** To determine which control strategies are most likely to achieve measurable results, assess the following:

- ♦ **_Participation_** — What portion of the targeted audience is likely to make the desired behavior change?
- ♦ **_Loading_** — What portion of the source's total loading will be eliminated if the entire targeted audience makes the desired behavior change?
- ♦ **_Cost_** — How much will it cost the agency to implement the program and how much will it cost the targeted audience?

To determine which strategies are most worthwhile, determine an estimated load reduction from the estimated participation and loading for each control strategy and compare it to the estimated cost of the control strategy. Information on participation factors and costs may be difficult to find. As a starting point, Tables 5-1 and 5-2 summarize participation rates from the examples and case studies described in this report. Except where noted, participation rates are for the first year of the program. Limited information is available concerning how these rates change with time. Table 5-3 summarizes program costs for the examples and case studies described in this report.

Table 5-1. Business Audience Participation Rates

Strategy	Participation Rate	Agency / Source	Notes
Business Audience - Behavior Change			
CESQG On-site Assistance Requests	0.1%	King County LHWMP	general outreach to all businesses (~400,000)
Behavior Change resulting from 0n-Site Assistance	79%	King County LHWMP	of 400 businesses visited
Nutrient Management Plan Implementation in each region	50%-100%	Wisconsin DNR	statewide participation by 550 farmers
Vehicle Service BMP Compliance	50%	West County Wastewater District	1st year based on local limits compliance
Vehicle Service BMP Compliance	100%	West County Wastewater District	3rd year based on local limits compliance
Business Recognition Program	0.33%	King County LHWMP	general outreach to all businesses (~45,000)
Business Recognition Program	40%	Palo Alto RWQCP	1st year of program, regulatory element to program
Business Recognition Program	92%	Palo Alto RWQCP	5th year of program, regulatory element to program
Business Audience - Environmental Improvement			
Copper pH Control	55%	Novato Sanitary District	based on influent concentration change
Vehicle Service BMP Compliance	80% to 99%	West County Wastewater District	based on facility discharge change
Printers BMP Compliance	95%	Union Sanitary District	based on facility discharge change
Photoprocessor Program	96%	Palo Alto RWQCP	based on effluent concentration change, regulatory program

Table 5-2. Residential Audience Participation Rate

Strategy	Participation Rate	Agency / Source	Notes
Residential Audience - Increased Awareness			
Knows difference between storm drain & sanitary sewer	~75%	SFWPPP	Biannual awareness survey
Street signs - Don't pour motor oil/ toxics down drain	33%	SFWPPP	Biannual awareness survey, 1500 signs in three languages
Multi-media ad campaign	40%	SFWPPP	Biannual awareness survey
TV ads on oil recycling	32%	SFWPPP	Biannual awareness survey
Utility bill inserts on safer housecleaners	16%	SFWPPP	Biannual awareness survey
TV ads on gardening practices	13%	SFWPPP	non-statistical phone banking to 777 residents
Understands destination of storm drain	37%	CCCWP	annual public opinion survey
Recall Pesticide Ad Campaign	23%	King County LHWMP	1994-96 multi-media focus, on radio and bus ads
Attitude Change After Ad Campaign	10%	King County LHWMP	1998 natural lawn care campaign
Recall Pesticide Ad Campaign	36%	King County LHWMP	1998 natural lawn care campaign
Recall Pesticide Ad Messages	24%	King County LHWMP	1998 natural lawn care campaign
Recall Pesticide Brochure	24%	King County LHWMP	1997 natural lawn care campaign
Residential Audience - Behavior Change			
Info. Request from Bill Inserts	3%	SFWPPP	4 color insert about guides in 165,000 bills
Behavior change resulting from educational guides	75-80%	SFWPPP	based on mailed surveys
Using safe pesticide handling practices	30% - 40%	SFWPPP	based on mailed surveys
Street signs- Don't pour motor oil/ toxics down drain	8%	SFWPPP	Biannual awareness survey,1500 signs in three languages
Car wash coupon return rate	10 - 12%	Palo Alto RWQCP	
Training workshop on water education	80%	Washington State Dept. of Ecology	teachers using activities from training
Changed a lawn care practice	5%	King County LHWMP	1997 natural lawn care campaign
Changed a housecleaning practice	82%	King County LHWMP	Classroom presentations to 6800 students and 190 teachers
Composting ad campaign, ban on disposal of yard debris	70%	Montgomery County DEP	1995 survey response saying they grasscycled or composted.
Increase in alternative, less toxic pest control sales	17%	Central Contra Costa Sanitary District	Pilot Program - results at one store
Decrease in more toxic pest control product sales	25%	Central Contra Costa Sanitary District	Pilot Program - results at one store
Survey Response Rates			
Mailed survey response	11%	SFWPPP	4000-6000 surveys mailed
Quantitative survey response	30% - 55%	SFWPPP	~1000 calls made
Response to mailed survey on classroom presentation	49%	King County LHWMP	Classroom presentations to 6800 students and 190 teachers

Table 5-3. Source Control Program Costs

Strategy	Cost	Agency / Source	Service Area Population	No. of Businesses	Notes
Overall Budgets					
Annual public education budget	$150,000	SFWPPP	750,000		PLUS 1 FTE
Annual public education budget	$300,000	CCWP	1,000,000		
Annual p2 budget	$50,000	West County Wastewater District	85,000	46	vehicle service facilities
Annual p2 budget	$450,000	Palo Alto RWQCP	236,000		
Annual p2 budget	$300,000	WLSSD	130,000		
Budgets for Individual Programs					
Neighborhood/community outreach	$15,000	SFWPPP	750,000		annual cost
Vehicle service p2 program	$50,000	Palo Alto RWQCP	236,000	330	vehicle service facilities
Nutrient Management Pilot Project	$1,000,000	Wisconsin DNR			statewide project
Business recognition program	$80,000	King County LWHMP		150	plus 1.2 FTE
Dental outreach program	$150,000	WLSSD	130,000		total over 5 years
Composting public education campaign	$296,000	Montgomery County DEP	750,000		average annual cost
Costs for Certain Program Elements					
Quantitative phone survey	$20,000	SFWPPP	750,000		~1000 calls made
Phone banking(non-quant.)	$3,000	SFWPPP	750,000		~777 calls made
Quantitative phone survey	$20,000-$25,000	CCWP	1,000,000		~400 surveys conducted
TV ad campaign	$15,000	SFWPPP	750,000		~$50/spot
Bill insert	$5,000	SFWPPP	750,000		includes printing 165,000
Educational fan guide	$5,000 - $20,000	SFWPPP	750,000		not including printing
4 focus groups	$20,000-$25,000	CCWP	1,000,000		
Audience segmentation study	$100,000	LA County Stormwater Program			
14 training workshops on water education	$52,200	Washington Dep. of Ecology			statewide project

5. ***Establish a goal.*** A goal may be set at any point during the development process. The goal is the desired outcome of the program and may be set based on:
   ♦ A reference condition (that is, the condition that would exist with out human interference);
   ♦ The reduction necessary to meet a permit limit or other regulatory or environmental standard;
   ♦ A reduction that can be realistically achieved based on the estimated load reductions determined in the previous step; and
   ♦ Performance necessary to meet an intermediate goal (for example, compliance rate with a regulatory program and response rate to an outreach program).

Water Environment Research Foundation

6. ***Implement the program.*** Part of program implementation involves selection of an effectiveness measurement tool to assess the program. Before choosing assessment tools, determine what information is being sought about the program. The tools are then chosen based on:

♦ The ability to measure achievement of the goal;
♦ The target audience and control strategy chosen;
♦ Whether or not assessment is necessary during the program or can be deferred until the program is completed; and
♦ What stage the program is focusing on (that is, increased awareness, behavior change, and environmental improvement).

Elements that allow effectiveness measurement are put in place at the beginning of program implementation. For example, base line surveying or monitoring is conducted, a telephone number to receive responses to a campaign is set up, or survey cards are added to outreach materials.

7. ***Evaluate effectiveness.*** Based on the effectiveness measurement, the agency determines what it has learned from the program as follows:

♦ Has the program's goal been achieved?
♦ What were the most effective aspects of this project?
♦ What changes need to be made to achieve better results?

8. ***Modify program.*** The results of the effectiveness measurement will help determine future directions for the program with respect to:

♦ Additional strategies to address this source if the desired results were not achieved,
♦ Alternative sources to work with if no further reductions are possible from this project's source, and
♦ New issues to pursue if this pollutant or waste stream issue was adequately addressed by the program.

In Chapter 2, the Palo Alto (Calif.) Mercury Pollution Prevention Program was used to illustrate how the framework is used.

5.2 Selecting an Effectiveness Measurement Tool

While effectiveness measurement of source control programs is not widespread, agencies representing a range of sizes, focuses, and pollutant issues were found to be measuring the effectiveness of their programs. Examples of these programs are presented in Chapters 2, 3, and 4 and are also listed in Table 5-4. Examples that are presented as case studies are numbered in Table 5-4.

Effectiveness measurement tools identified in this report include

♦ Surveys
— Quantitative
— Targeted
— Telephone banking;

- ♦ Group feedback
  - — Focus groups
  - — Workshops;
- ♦ Pilot Study;
- ♦ Environmental analysis;
  - — Effluent/receiving water monitoring
  - — Discharger sampling;
- ♦ Tracking responses;
- ♦ Tracking sales;
- ♦ Modeling;
- ♦ Cost-benefit analysis;

Table 5-4. Summary of Case Studies/Examples Used in the Phase 1 Report

Program	Project	EPA Region	Program Type*	Program Audience
City of Hayward	Vehicle washing	9	WW	Business
Palo Alto RWQCP	Mercury P2 Plan	9	WW	Residential
Palo Alto RWQCP	Thermometer Turn-Ins	9	WW	Residential
1 San Francisco WPPP	Public Education Program	9	WW	Residential
Contra Costa Clean Water Program	Public Education Program	9	SW	Residential
City of Davis	Healthy Gardens Program	9	WW	Residential
King County LHWMP	Facility Managers Project	10	HW	Business
Contra Costa Clean Water Program	High School Outreach	9	SW	Schools
Palo Alto RWQCP	Silver Program	9	WW	Business
Novato Sanitary District	Copper Program	9	WW	Local Gov't
2 West County Wastewater District	Vehicle Service Facility Program	9	WW	Business
3 Union Sanitary District Pollution Prevention	Printers Program	9	WW	Business
San Francisco WPPP	Residential Guides	9	WW	Residential
4 Palo Alto RWQCP	Car Wash Coupons	9	WW	Residential
King County Hazardous Waste Mgmt. Program	Hazardous Household Product Use	10	HW	Residential
Central Contra Costa Sanitary District	Pesticide Outreach Program	9	WW	Residential
University of California, Berkeley	Pesticide Use Habits	9	SW	Residential
Sacramento Stormwater Program	Stormwater Program	9	SW	General
Los Angeles County Stormwater Program	Business Outreach	9	SW	Business
5 Montgomery County DEP	Composting Program	3	Solid Waste	Residential
6 King County LHWMP	On-site Consultation Team	10	HW	Business
Chesapeake Bay	Businesses for the Bay	3	Watershed	Business
Palo Alto RWQCP	Clean Bay Business Program	9	WW	Business
Bay Area Stormwater Management Agencies Assoc.	Surface Cleaner Program	9	SW	Business
7 Wisconsin Department of Agriculture	Nutrient Management Pilot Project	5	Watershed	Agriculture
8 Sacramento Stormwater Program	Copper Control Measures	9	SW	Business
9 Contra Costa Clean Water Program	Public Education Program	9	SW	Residential
City of Greenville	Pesticide Outreach	6	WW	Residential
San Francisco WPPP	Public Education Program	9	WW	Residential
10 Los Angeles County Stormwater Program	Audience Segmentation Study	9	SW	Residential
11 Washington State Dep't. of Ecology	Water Education for Teachers	10	Watershed	Schools
12 King County LHWMP	Envirostars	10	HW	Business
13 Western Lake Superior Sanitary Dist.	Dental Program	5	WW	Business
14 King County LHWMP	Green Gardening/ Natural Lawn Care	10	HW	Residential
15 King County LHWMP	School Program	10	HW	Schools

*WW = Wastewater Program, SW = Stormwater Program, HW = Hazardous Waste Program

Water Environment Research Foundation

- ♦ Inspections/site visits;
- ♦ Participation rates; and
- ♦ Estimated load reductions.

Selection of effectiveness measurement tools by source control programs is influenced by the following factors:

- ♦ Target audience (that is, business, residential, schools, agriculture, and so on);
- ♦ Timing, with respect to project planning and implementation (that is, before, during, or after a project is conducted); and
- ♦ Stage, with respect to environmental improvement (that is, program implementation, increased awareness, behavior change, and environmental improvement).

For the examples used in this report, the effectiveness measurement tool and the influencing factors are summarized in Table 5-5.

Based on a review of Table 5-5, the effectiveness tools that are most appropriate to a source control strategy may be chosen based on the following considerations:

- ♦ ***Programs targeting business audiences.*** Tools commonly used include measurement of participation or compliance, rates, discharger sampling, and site visits/inspections. Other tools that have been used successfully include cost-benefit analysis, estimated load reductions, and focus groups. Participation rates are a useful measure when the control strategy used is a recognition or certification program. Discharger or effluent sampling is used most effectively when a specific business category is targeted. Effluent or influent sampling is only an effective indicator of program performance if a single source (that is, business category) is responsible for the major portion of a pollutant's loading.
- ♦ ***Programs targeting residential audiences.*** Most of the control strategies used for this audience are based on educational outreach materials and methods of advertising this information to the public. Effectiveness measurement tools commonly used include quantitative and targeted surveys, tracking responses, and focus groups. Other tools that have been used successfully when adequate data are available include estimated load reductions, tracking sales, effluent toxicity, and modeling.
- ♦ ***Assessment during program planning***. The most commonly used tools during the planning process include estimated load reductions, focus groups, modeling, and quantitative surveys.
- ♦ ***Assessment while a project is being conducted.*** Certain tools can be used to assess a program as it is being implemented. These tools include inspections/site visits and participation rates for business-oriented projects and tracking responses or sales patterns for residential audience projects.
- ♦ ***Assessment after a project is completed.*** Discharger and effluent sampling are conducted to assess the impact of an implemented project that targets a business audience. Targeted surveys are used to assess the impact of an outreach program targeting the residential sector, specifically with respect to whether workshops or education materials resulted in positive behavior changes. Quantitative surveys can also be used to assess the impact of residential outreach, specifically with respect to the overall impact of an advertising campaign.

5.3 Findings and Recommendations

Based on information presented in this report, findings are discussed in this section with respect to barriers to conducting evaluation, benefits realized from program evaluation, and lessons learned from other fields. In addition, recommendations are made for conducting the demonstration projects that will test the framework and tools presented in this report.

5.3.1 Why Don't Agencies Evaluate Their Source Control Programs?

As shown in many of the case studies for this report, valuable information can be obtained from program evaluation. Agencies who have institutionalized effectiveness measurement or conducted program assessment for a number of years use it to plan their programs, choose where to focus resources, and determine how to modify their programs to improve them. These agencies also use assessment results to gain management support for their programs and to obtain additional funding. The agencies have been monitoring the effectiveness of their programs for so long that they "instinctively" know which strategies will work best in certain situations. Because their programs are so effective, the agencies appear to have more resources available to them. While their resources may not be much greater than programs of similar size, the agencies are able to focus efforts more effectively and get more "bang for their buck."

Table 5-5. Effectiveness Measurement Summary

Project	Audience	Control Strategy	Effectiveness Measurement		
			Tool	Timing during Project	Stage to Improving the Environment
Nutrient Management Pilot Project	Agriculture	Public Private Partnership	Participation rates	during	Behavior change
Copper Control Measures	Business	Framework/ BMP education	Estimated load reductions	before	Env. Improvement
Business Outreach		Workshops	Cost benefit analysis	before	Increased awareness
Facility Managers Project		Business Assistance	Focus group	before	Increased awareness
Dental Program	*	Business Partnership, BMP education	Discharger Sampling, participation rates, site visits	during	Behavior change
On-site Consultation Program		Technical Assistance	Inspections/ site visits	during	Behavior change
Businesses for the Bay		Recognition Program	Participation rates	during	Behavior change
Clean Bay Business Program		Recognition Program	Participation rates	during	Behavior change
Surface Cleaner Program	*	Certification Program	Participation rates	during	Behavior change
Envirostars		Recognition Program	Participation rates	during	Behavior change
Vehicle Service Facility Program	*	BMP education/ site visits	Discharger Sampling	after	Env. Improvement
Printers Program	*	BMP education/ site visits	Discharger Sampling	after	Env. Improvement
Silver Program	*	Permit/ zero discharge	Effluent Sampling	after	Env. Improvement
Vehicle washing	*	Framework/ Carwash permits	Effluent Sampling	after	Env. Improvement
Stormwater Program	General	Overall Program	Modeling	before	Env. Improvement
Copper Program	Local Gov't	pH control	Effluent Sampling	after	Env. Improvement
Public Education Program	Residential	Outreach campaign	Focus group	before	Increased awareness
Public Education Program		Overall Program	Quantitative Survey	after	Increased awareness
Audience Segmentation Study		Outreach campaign	Quantitative Survey	before	Increased awareness
Green Gardening/ Natural Lawn Care	**	Advertising/ outreach	Quantitative Survey	after	Increased awareness
Public Education Program		Educational guides, Media Advertising	Quantitative surveys, Targeted Surveys, Phone Banking	after	Increased awareness, Behavior change
Healthy Gardens Program		Pesticide Outreach	Stakeholders Workshop	before	Increased awareness
Pesticide Use Habits		Pesticide Use Habits	Modeling	before	Behavior change
Public Education Program		Outreach messages	Quantitative Survey	before	Behavior change
Thermometer Turn-Ins		Outreach/ coupons	Tracking responses	during	Behavior change
Car Wash Coupons		Outreach/ advertising	Tracking responses	during	Behavior change
Residential Guides		Advertising guides	Tracking responses	during	Behavior change
Composting Program		Advertising, workshops	Cost-benefit analysis	after	Behavior change
Pesticide Outreach		Advertising/other outreach	Effluent Toxicity	after	Env. Improvement
Mercury Pollution Prevention Plan		Overall Program	Estimated load reductions	before	Env. Improvement
Water Education for Teachers	Schools	Training workshop	Targeted survey	after	Behavior change
High School Outreach	**	Public outreach	Pilot Study	after	Increased awareness
School Program		Classroom presentations	Targeted surveys	after	Behavior change

*Specific business category targeted (e.g., printers);
**Specific segment of residential audience targeted (e.g., gardeners)

Although there are good reasons to conduct evaluation, many agencies avoid effectiveness measurement for a variety of reasons. Some of these reasons are discussed here.

♦ ***Evaluation is too expensive.*** Some tools, such as surveys and monitoring that provide statistically valid results, are expensive. However, less expensive strategies are available including tracking responses, measuring participation rates, or conducting targeted surveys. While the resulting information may not be scientific, it can still be informative. If planned from the beginning, there are several inexpensive ways to modify a program to allow evaluation. Adding a response card or telephone number to a brochure, providing switchboard operators with a log sheet to track calls, or color coding coupons or response cards can provide useful information at a minimal monetary investment.
There are also tools that may be worth the expense because they serve the dual purpose of providing effectiveness measurement and helping to implement certain program elements. Focus groups and site visits/inspections can serve as educational opportunities in addition to providing effectiveness measurement.

♦ ***I don't have the time or energy to conduct an effective evaluation,*** so it's not worth bothering with at all. If you have the money to conduct an evaluation, you have the time. Surveys and monitoring studies can always be contracted to someone with the appropriate knowledge and experience. Of course, an agency typically does not have an excess budget either. As previously noted, there are several simple tools that require a minimal additional time investment to return valuable information. For example, when Palo Alto tracked mercury thermometers turned into the household hazardous waste facility the add-on for evaluation was to record the number of people turning in the thermometers and the total number of thermometers turned in each day. At the end of the year, the time required to enter and analyze the data, as well as correlate this information to outreach efforts, was also small (less than 20 hours). If some time is spent initially, it is often possible to use existing program elements to assess effectiveness with only slight modifications or add-ons.

♦ ***I'm afraid that I'll find out my program is ineffective.*** It may look like we haven't done anything or wasted money and then we'll be required to do more. In reality, more time and money could be wasted continuing to do the same old thing that is having no impact beyond meeting a permit or other regulatory requirement. In addition, incorporating evaluation into a project from the beginning increases the likelihood that the program will have effective elements. The initial step to evaluating a program is to establish a base line. A well-defined starting point will help focus efforts more effectively. Effective planning involves research that should focus a project on the appropriate pollutant source or target audience and help to identify effective strategies for that source or audience.
Another approach to effectiveness measurement is to start small and measure the effectiveness of one element of a program as a "pilot study." Therefore, success or failure will not be a criticism of the overall effort. It is also important to realize that poor results for effectiveness measurement provide valuable information about what not to do in the future.

♦ ***I won't learn anything useful from evaluation.*** Many agencies that evaluate their programs do so because it is a requirement. In those cases, the most common use for the evaluation is to report it to management or regulatory authorities. Because these agencies do not see any benefit to evaluation, the type of evaluation conducted may only

be to track evidence of program implementation (number of brochures distributed, number of inspections conducted, and so on). As a result, there may be no useful information obtained. For information to be useful, evaluation needs to be incorporated from the beginning of a project, and the first questions asked should include the following:

— Where are we starting from and what do we already know?
— What do I want to learn about my program?
— What do I want to achieve with this program?

♦ ***I don't know how to evaluate my program.*** Evaluation has not been institutionalized for source control programs. Therefore, evaluation tools have not been well defined or made uniformly available. This report addresses this issue by compiling a list of tools and examples of how they are used.

♦ ***My boss doesn't care about evaluation and I've never had to do it before, so why should I start now?*** This is also a case of evaluation not being institutionalized. Accountability with respect to program results needs to be incorporated into project planning in the same way that budgets and time schedules are. The result may be a better program that will get a more positive response from the targeted audience, management, and/or regulatory authorities.

Incorporating effectiveness measurement into a project from the planning stage will help to develop a more focused, results-oriented program. A well-planned and well-executed program may get more support from management even if they do not realize that evaluation played a critical role. If the evaluation portion of the program is highlighted, it may encourage management to consider evaluation as an important program element in the future.

The only meaningful measure of a program's impact is changes in pollutant levels in influent, effluent, or sludge. While the goal of a program may be to see measurable changes in influent, effluent, or sludge pollutant levels, there are intermediate stages to environmental improvement that can be measured. In fact, environmental improvement may be a gradual process that is difficult to measure. Changes may be easier to observe at some of the intermediate stages. If the changes are scientific, quantitative results are desired before monitoring and surveys can be used. Monitoring of individual dischargers can be measured to see more noticeable changes than may be observed in the influent. Surveys can be conducted to assess changes in awareness and behavior that will ultimately lead to environmental improvement. However, for these results to be statistically valid, the surveys or monitoring plans must be developed carefully and adequate data must be collected. While extremely useful, these strategies may also be costly.

There are no well-defined indicators to measure stormwater program performance. Appropriate methods for measuring stormwater program performance are still under development. One approach under development is the use of environmental indicators. Environmental indicators are parameters that can be used to approximate overall conditions in receiving waters and provide benchmarks for assessing the success of management efforts. These indicators can be divided into the following categories: water quality, physical/hydrological, biological, social, programmatic, and site related. Once fully developed, water quality and biological indicators may be the most direct measure of environmental improvement for stormwater programs. Tools described in this report may work well for evaluation of the intermediate steps of increased awareness and behavior change as they apply to stormwater programs.

5.3.2   Why Should Agencies Evaluate Their Programs?

Benefits realized from effectiveness measurement include gaining support and funding for a program, identifying the best outreach methods, targeting a program to the right audience, and keeping the program on track. Examples from this report are listed in this section.

Agencies are able to justify their programs and gain support and additional funding for them based on effectiveness measurement results. An example from the Volunteer-Led Investigations of Neighborhood Ecology, or the VINE Program, was the use of evaluation results to obtain funding to start a similar program in a new city. An assessment of the program's adaptability convinced the potential donor that the program could be adapted for use in Baltimore, and resulted in the donor funding the program (Holweg, 1997).

Agencies learn what methods work best to achieve different objectives. For example, Palo Alto and San Francisco's pollution prevention programs have learned that newspaper advertising is far less effective than utility bill inserts for distributing coupons or communicating offers for free brochures. Similarly, newspaper articles have been found to be more effective than newspaper advertisements. San Francisco also learned that street signs are effective for creating awareness of environmental issues.

Agencies learn what audiences are most receptive to certain messages and how to target outreach campaigns. The King County Green Gardening Campaign determined that the highest pesticide users in the Seattle-King County area were suburban homeowners over 30 years of age with incomes of more than $50,0000. Focusing on this audience resulted in a successful, effective campaign. Similarly, Montgomery County, Md., attributed the success of their composting program to shaping the campaign based on the results of initial surveys regarding the community's composting attitudes and behavior.

Agencies may also use effectiveness measurement to keep a program on track. When Palo Alto tracked thermometer turn-in rates, the number of thermometers turned in increased when newspaper articles were published on the topic. Additional newspaper articles were published in response to turn-in rates slowing over the summer months. This resulted in another peak in turn-in rates.

5.3.3   Lessons Learned from Other Fields

Evaluation is used in commercial and social marketing and in education. In many respects, the approaches and tools used for evaluation are similar to the framework and tools described in this report. Some additional tools and approaches used by market researchers and educators are summarized here.

Social marketing, which has been widely used to promote public health issues, has been used more recently to address environmental protection issues. The approach to developing a social marketing program, which is similar to the framework presented here, has planning, development, implementation, and assessment phases. Surveys and focus groups are widely used. Other tools employed in social marketing research include in-depth interviews, "gatekeeper" audits, central site interviews, forced exposure, and readability testing. In addition, some approaches that may be applicable to source control program effectiveness measurement include:

♦ Using survey data available from general marketing databases;
♦ Conducting a survey to assess an audience's knowledge, attitude, and practices associated with the social issue (process and outcome are evaluated by comparing later survey results to the initial survey);

- Assessing existing information regarding "product competition" or reasons that the target audience will not adopt the desired practices; and
- Comparing results from a marketing campaign to trends observed with a control group.

Educators also use several assessment tools to evaluate their programs. In addition to surveys and traditional testing, tools used to assess informal education programs include the use of outside observers, group interviews with children using open-ended questions and checklists asked verbally, and precoded log sheets to assess ongoing classroom activities. Some unusual approaches to assess children include analysis of children's drawings and extensive comparison to control groups based on national survey data and/or students not involved in the studied program. Educators often had to work with limited budgets when conducting program assessment. Two less-expensive approaches were the use of standardized checklists and precoded log sheets. For each of these approaches, an initial time investment was necessary to train people to use the materials and ensure that the forms were completed and returned.

5.3.4   Recommendations for Demonstration Projects

The framework and tools presented in this report will be tested by conducting demonstration projects with stormwater and wastewater source control programs. To obtain as much information as possible about source control program effectiveness measurement, these projects should be developed based on the following recommendations:

- Each demonstration project should follow the eight steps of the framework described in Chapter 2 and use one or more of the tools described in Chapter 3;
- Cost should be assessed for each effectiveness measurement tool, and identifying low-cost approaches to effectiveness measurement should be emphasized;
- Staffing requirements for each tool should be assessed with an emphasis on tools that can be used by agencies with small staffs;
- Different target audiences and pollutants should be the subject of each project;
- Demonstration projects should employ evaluation tools not previously used by the particular agency; and
- Ease of use and applicability to other projects should be assessed for each evaluation tool.

Case Studies

San Francisco Water Pollution Prevention Program, Public Education Program

The City and County of San Francisco Public Utilities Commission has a combined sewer system and operates three water pollution control plants (that is, Southeast, Oceanside, and Northpoint) that cover a service area of approximately 750,000 people. The Commission's pretreatment program regulates San Francisco industries and commercial businesses that discharge process wastewater into the city's combined sewer system. As part of the pretreatment program, and as required by its National Pollutant Discharge Elimination System (NPDES) permit, San Francisco conducts its Water Pollution Prevention Program (WPPP). The WPPP's strategies include identifying new sources of San Francisco's problem pollutants, guiding the city's industries and commercial businesses through a mandated pollution prevention approach, and implementing a comprehensive public education campaign. The WPPP has won several state and national public education awards, including the Water Environment Federation's 1997 Public Education Award. The WPPP has been recognized for effectively incorporating business marketing concepts to increase public awareness of water pollution and change behaviors that contribute to water pollution. The WPPP has developed several components based on the principle that there are several different ways that people learn. The three major components of the WPPP are as follows:

♦ ***Community and neighborhood outreach*** — This includes participating in local events such as festivals and street fairs; conducting workshops and presentations for community groups, churches, and school groups; and placing articles in local newsletters.

♦ ***Educational materials*** — The cornerstone of the WPPP's educational materials are their residential guides, *Clean It!, Grow It!, Remodel It!, Fix It!,* and *Control It!* Each guide presents information on pollution prevention methods that stress ease and convenience for the user. At the same time, the guides highlight benefits of the desired behavior change without overwhelming the audience with "environmental information" that they may not understand or relate to. The WPPP has found that individuals do not necessarily change bad habits for environmental reasons. Change is more likely to occur when the issue is presented in a personal message about health, safety, and family. The guides use simple language and graphics to make them easier to understand.

♦ ***Advertising/media coverage*** — Various media methods are used to educate and create awareness and to advertise the WPPP's educational materials. Cable television commercials as well as bus advertisements, bill inserts, and newspaper articles are used.

Elements of the public education program that are evaluated include

- ◆ Methods of reaching the public (that is, television advertisements, bill inserts, and so on);
- ◆ Residential guides; and
- ◆ General awareness of water pollution prevention.

The San Francisco WPPP uses evaluation to determine which strategies work best to convey different types of messages and to measure the effectiveness of individual programs and products. The WPPP uses several methods to evaluate its program, matching the evaluation tool to the control strategy and the information desired. Evaluation methods used by the WPPP include targeted mailed surveys, quantitative telephone surveys, and telephone banking. These methods and the strategies to which they are applied are described in the following sections.

Mailed Surveys

Mailed surveys are used by the WPPP to assess increased knowledge and specific behavior changes. The usefulness of the residential guides was evaluated by mailing surveys to people who requested guides. Surveys were mailed approximately 6 months after the guides were mailed to assess awareness and behavior changes as a result of guide use. Return rates for surveys regarding the *Remodel It!*, *Clean It!*, and *Grow It!* guides are shown in Table A-1.

Table A-1. Mailed Survey Return Rates

	Number of Surveys Mailed	Number of Survey Responses
Remodel It!	3900	525(13%)
Clean It!	6000	713 (12%)
Grow It!	5000	323 (6.5%)

Survey respondents evaluated each of the three guides favorably. Results indicated that 85% to 95% of the respondents found the information in each of the three guides helpful and felt that the guides had increased their overall awareness of water pollution.

More than 80% of the respondents had tried the products and methods described in the *Clean It!* and *Remodel It*! guides and had been encouraged by information in the guides pertaining to purchasing less hazardous products. At least half of the respondents had shared the *Clean It!* or *Remodel It!* guides and/or the information with someone else. Approximately a quarter of the respondents had brought leftover latex cleaners, paints, pesticides, and automotive products to collection facilities within the last 6 months.

For the *Grow It!* guide, almost 75% of the respondents indicated that they were using less-toxic pest control methods from the guide. Between 30% and 40% of the respondents indicated that they were using specific safe practices (that is, not using pesticides when rain is forecast, not pouring pesticides down the drain, using pesticides more carefully, and not using pesticides) when handling and disposing of pesticides.

Biannual Awareness Survey

Overall program assessment and behavior profiles are determined using a city-wide, biannual quantitative telephone survey that has been conducted since 1992. Survey response rates are shown in Table A-2. The survey consists of two parts. The first part asks basic questions about demographics, what products people use, how they dispose of these products, and who they think contributes most to water pollution. These questions change only slightly from year to year. The second part of the survey is used to focus on particular issues, identify common characteristics of groups that use certain products, identify the most effective methods of

outreach, and find out what would motivate individuals to change their behavior. Products that are typically focused on in the second part of the survey are pesticides, motor oil, house cleaning products, and paint-related products. These products have been identified as residential sources of pollutants that may affect water quality.

Table A-2. Awareness Survey Response Rates

	1992	1994	1996	1998
Number surveyed	602	459	401	350
Response rate (Surveyed/ Calls made)	51%	56%	51%	31%

Topics covered in the first part of the survey include the following:

♦ ***What types of toxic materials are used by households*** — These results have remained fairly constant for most chemicals over the time period of the survey. Selected survey results, shown in Table A-3, indicate that a major portion of the audience uses motor oil, paint-related products, housecleaning products, and pesticides. The WPPP has focused much of its outreach on these products based on this information. A drop in the use of motor oil (47% to 26%), garden and yard chemicals (30% to 14%), and antifreeze (32% to 16%) was observed between 1992 and 1996.

Table A-3. Household Use of Toxic Materials in San Francisco

	1992	1994	1996
Motor oil	47%	31%	26%
House paint	42%	39%	35%
Root eradicator	3%	4%	6%
Photographic chemicals	3%	2%	2%
Chemical cleaners		65%	67%
Garden and yard chemicals	30%	21%	14%
Antifreeze	32%	19%	16%

♦ ***Awareness of environmental issues*** — Knowledge is assessed for topics including treatment plant effectiveness and the effect of disposing materials down the drain. In addition, practices such as reading product labels, belonging to environmental organizations, and buying nontoxic products are evaluated. Selected results are shown in Table A-4.

Table A-4. Environmental Awareness

	1992	1994	1996
Read product labels	~50%	51%	57%
Member of environmental organization	~16%	14%	14%
Try to purchase non-toxic products		25%	
Knows that motor oil, housepaint down drain can go to Bay untreated		78%	77%
Treatment plant ineffective in treating motor oil		33%	25%
Treatment plant ineffective in treating raw sewage		7%	6%
Toxics down drain poses little risk		27%	32%
HHW collection facility poses little risk		67%	60%

Household hazardous waste

- ♦ ***Disposal practices*** — Survey respondents indicate what types of materials they dispose of down street drains or house drains. The portion of respondents that disposes of at least one type of toxic product down a street or house drain is measured and referred to as the "UDDP (uses dangerous disposal practices) rate." The rate ranged from 3.5% to 6.3% between 1992 and 1996.
- ♦ ***Perceived sources of water pollution*** — The WPPP uses this set of questions to determine if people view residential activity as contributing to water pollution. The public continues to view industry and commercial businesses as more likely to be significant contributors to water pollution and does not see households as significant contributors. Between 1992 and 1996, 23% to 31% of respondents felt that households were significant contributors to water pollution. Business and manufacturing entities were seen as significant contributors to water pollution by 50% to 60% of the respondents.
- ♦ ***Where people get information on environmental issues*** — This issue was covered in the 1992 awareness survey, the results of which showed that newspapers (41%) and television (21%) are the primary information sources. The WPPP has used both of these methods for outreach and has developed several successful television spots.

The survey is also cross-tabulated to see if there are any demographic indicators of certain behaviors or perceptions. This information is used to focus outreach to the appropriate sectors of the population.

The biannual awareness survey is also used to evaluate specific advertising campaigns. In 1994, the survey assessed the effectiveness of a street sign advertising campaign. Approximately 1,500 street signs were posted in English, Chinese, and Spanish warning about pouring motor oil and other toxics down the drain. Survey results indicated that

- ♦ Approximately 33% of the respondents saw the signs;
- ♦ Approximately 75% of the respondents who saw the signs said they had educational value; and
- ♦ Of those respondents who thought they had educational value, 41% said they learned something and 81% of those who learned something said they would change their behavior as a result.

Therefore, one-third of the respondents remembered the signs and approximately 8% of the respondents indicated that they would change their behavior as a result.

In 1996, the survey evaluated safer housecleaning, oil recycling, and less-toxic gardening advertising campaigns in San Francisco (City and County of San Francisco, 1996). The Safer Housecleaning Campaign was conducted during April and May of 1996 and included street signs, bus advertisements, radio and television public service announcements, newspaper stories, Muni (that is, San Francisco's public transportation/bus system) electronic signs, and utility bill inserts. The Oil Recycling Campaign was also conducted during April and May of 1996 and included street signs, promotions at automobile supply stores, radio and television commercials, and newspaper stories. The Less-Toxic Gardening Campaign, conducted in May 1995, included bus advertisements, radio and television public service announcements, newspaper stories, free workshops at garden supply stores, and utility bill inserts.

At least one campaign was remembered by 40% of survey participants. Approximately 11% remembered the Safer Housecleaning Campaign, 24% remembered the Oil Recycling Campaign, and 5.5% remembered the year-old Less-Toxic Gardening Campaign. The street signs and utility bill inserts were found to be particularly effective for the Safer Housecleaning

Campaign. Of those respondents who said they learned something, 51% said they learned it from street sign advertisements and 16% said they learned it from utility bill inserts. Street signs and television were found to be the most effective tools for the Oil Recycling Campaign. Of those respondents who said they learned something from the Oil Recycling Campaign, 41% said they learned it from street signs and 32% said they learned it from the television advertisements.

Based on these results, it is fair to assume that public education campaigns received significant exposure in San Francisco.

Telephone Banking

The WPPP uses telephone banking to assess the public's awareness level. While not a scientific analysis, telephone banking is still a useful tool for this purpose. For example, a television commercial's ability to convey a message and increase awareness was measured using this tool. A commercial is shown in a certain area of the city and, after the commercial has run for 2 or 3 weeks, random telephone calls are made within the area that the commercial is shown. People are asked if they remember the commercial and what the message of the commercial was.

In April and May of 1998, an animated commercial was aired on cable television in the western part of San Francisco. Effectiveness was measured based on ratings and telephone banking. With respect to ratings, a goal was set to reach 68.1% of cable households in the area an average of 6.5 times, which would correspond to achieving 441 gross rating points during the campaign. Nielsen ratings indicated that the schedule actually achieved 456 gross rating points, exceeding the goal.

At the end of the campaign, 777 residents of the targeted area were called. Approximately 13% of those contacted remembered the animated spot on gardening. Of those respondents who remembered the spot, 60% said the spot increased their overall awareness of water pollution, 32% said seeing the commercial made them think about their own use of pesticides, 4% called to request a copy of *Grow It!*, 12% remembered the WPPP's logo, and 54% said they saw the spot two or more times.

The target audience for the commercials was gardeners over the age of 35. Of those in the target audience who saw the spot, 73% were over 35 and 72% had a yard or garden. Therefore, the spots reached the key target audience.

The cost of San Francisco's overall public education program and costs of other selected elements are shown Table A-5.

Table A-5. WPPP Public Education Program Costs

Item	Cost
Annual Public Education Budget	$150,000 + 1 FTE
Biannual phone survey	$20,000
Phone banking	$3000
TV ad campaign	$15,000 (~$50/ spot)
Bill insert (including printing 165,000)	$5000
Guides (per guide to develop and produce but not print)	$5,000-$20,000
Neighborhood and community outreach	$15,0000/year

Palo Alto Regional Water Quality Control Plant Car Wash Coupons

One element of the Palo Alto, Calif., Regional Water Quality Control Plant (RWQCP) Pollution Prevention Program is the Clean Bay Business Program targeting vehicle service facilities. For a vehicle service facility to qualify as a Clean Bay Business, it must comply with the city's ordinance and implement a variety of best management practices (BMP). Strategies used to get businesses to comply/participate in the program include onsite visits, positive incentives (Clean Bay Business recognition), and, when necessary, enforcement. One of the ways that the RWQCP publicizes the Clean Bay Business Program is to offer discount coupons to be redeemed at car washes that qualify as Clean Bay Businesses. The number of coupons redeemed is tracked and the effectiveness of the different ways of distributing the coupons is also assessed.

The effectiveness of the car wash coupons is evaluated with respect to the percentage of coupons returned and the method of distribution that resulted in the most coupons being returned. The way this is done is by using different colored coupons for different methods of distribution, keeping track of how many coupons were distributed using each method, and tabulating how many coupons of each color are returned.

During the summer of 1998, staff from the RWQCP distributed a total of 6,100 car wash coupons in a variety of locations. An additional 24,000 coupons were distributed as a newspaper advertisement through the *Mountain View Voice* and an additional 30,000 coupons were distributed to Palo Alto residents by means of a utility bill insert (see Figures A-1 and A-2). Distribution for the government agencies group was routed via employee paychecks and at other public distribution points. In 1998, 2,671 coupons were used.
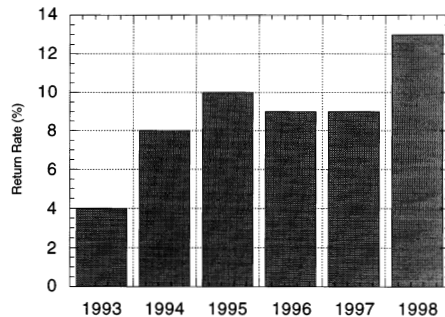
Figure A-1. Annual Car Wash Coupon Return Rates

The return rates for distribution locations excluding the newspaper advertisement and utility bill insert for each of the 6 years of the program are illustrated in the Figure A-1.

The lowest coupon return rate was in 1993, the first year of the program. This was most likely because the coupon was printed on dark gray paper. Since 1994, the coupon has been printed on nine bright colors of (recycled) paper and designed to appear more like a coupon; both of these factors have made the coupon more attractive to the reader.

Distribution locations or entities that have achieved the highest return rate since 1994 are oil change services, automobile parts stores, and government employee paychecks. These

locations or entities have consistently done well over the last 5 years. Other distribution methods that are used include utility bill inserts; counters at community centers, libraries, and city hall; and local corporation employee paychecks. Although these methods do not have the highest return rates, they are still employed because they reach residents and help increase their awareness of stormwater pollution. Distribution methods, such as placing coupons on parked cars at shopping malls and hand delivering coupons to residential homes, were tried in previous years but were discontinued because they were labor intensive and did not generate high coupon return rates. Figure A-2 illustrates return rates from various distribution locations in 1998.

A-Automobile Parts Store;
C-Government;
E-Commercial Businesses;
G-Newspaper Ad

B-Oil Change Services;
D-Miscellaneous Locations;
F-Utility Bill Insert;

Figure A-2. Car Wash Coupon Return Rates

The budget for the vehicle service facility program is approximately $50,000 per year, approximately $20,000 of which is for site visits and sampling. The car wash publicity program is one element of the vehicle service facility program. Tracking the car wash coupons involves time — "a few hours per year" — to keep records and compile responses. In 1998, 2,671 coupons, which are $2 each, were redeemed for a total expense of $5,342.

Onsite Consultation Team Program, King County, Wash., Local Hazardous Waste Management Program

The King County Local Hazardous Waste Program (LHWMP), which has a staff size of 50 to 60 employees and a budget of $10 million per year, consists of five to 10 household programs and business programs that include four field inspections programs, a telephone line, an industrial materials exchange, and incentive programs.

Field inspections programs consist of the Survey Team, Response Network Team, Audit Team, and the Onsite Consultation Team.

The Onsite Consultation Team's goals are to:

♦ Reduce waste reduction by 15,000 lb/yr;
♦ Divert 15,000 lb/yr to proper disposal;

- Move 3,000 gal of hazardous liquid to safe storage;
- Improve environmental compliance by 60% (based on the number of businesses out of compliance); and
- Conduct 425 site visits per year.

The King County LHWMP has a staff of 6 and an annual budget of $327,000, of which $286,000 is spent per year on salaries. The Program has been operating since May 1992. The Program's staff provides technical and regulatory compliance assistance to conditionally exempt small quantity generators (CESQG) (that is, those that generate less than 220 lb of hazardous waste per calendar month) or potential CESQG at their request or upon referral from other LHWMP programs or the Department of Ecology. The LHWMP staff helps business owners develop practical hazardous waste management programs, reduce their generated waste, and comply with regulations. Approximately 40,000 to 60,000 small quantity generators of hazardous waste in King County are eligible to use the program. Approximately 400 small quantity generators express an interest in onsite consultation program assistance each year.

Revisits to assess business response to technical assistance are an integral part of the Onsite Consultation Team Program. After the first inspection, all businesses receive a detailed letter within approximately 3 weeks of the inspection date. The letter provides observations and recommendations that may include developing a practical hazardous waste handling program, finding alternatives, reducing waste, and complying with applicable regulations. All businesses with serious waste management issues receive follow-up visits. These visits reinforce guidance for businesses and provide valuable information on effectiveness. The LHWMP staff checks to see if changes have occurred in the following categories:

- Regulatory compliance,
- Waste generation rate,
- Waste diversion from municipal waste streams, and
- Hazardous materials storage practices.

Since 1992, cumulative data from follow-up inspections indicate that the program has reduced hazardous waste generation by 2.75 million pounds and caused 9.37 million pounds of hazardous waste to be diverted from improper disposal. In addition, 68% of businesses showed improvements in compliance with program BMP.

Onsite Consultation Team Program effectiveness is assessed annually based on established objectives for performance, environmental impact, and behavior change. The program's 1997 data are summarized as follows (performance is based on the number of inspections, telephone responses, number of businesses reached, and the level of satisfaction):

- A total of 567 site inspections were made (339 (60%) were initial visits and 228 (40%) were return inspections);
- A total of 186 telephone consultations were made in response to requests from businesses for technical and regulatory guidance;
- Guidance was provided to 237 business representatives through 12 presentations;
- Ninety-one percent of surveyed businesses said they were satisfied with the program's services; and
- Services were provided to businesses in 22 municipalities.

The impact of the program was measured based on estimated reductions in hazardous waste streams and behavior changes. In 1997, the following environmental impacts and resulting cost savings were identified:

- ♦ Approximately 45,000 lb/yr of hazardous waste will no longer be generated;
- ♦ Approximately 60,000 lb/yr of hazardous waste were diverted from municipal waste streams;
- ♦ A total of 5,500 flammable, solvent-contaminated shop towels were diverted from municipal landfills;
- ♦ Approximately 7,800 gal of hazardous materials at risk of environmental release were moved to proper storage; and
- ♦ A total of $29,000 in savings to businesses by reducing waste generation.

In 1997, the following behavior changes were observed as a result of the program:

- ♦ Approximately 79% of revisited sites made positive behavior changes,
- ♦ Approximately 14% of the sites reduced their generator status,
- ♦ Businesses saved $29,000 by reducing waste generation, and
- ♦ Approximately 68% of businesses that were using improper storage or disposal practices had improved those practices on a follow-up visit.

Over the years, assessment has resulted in modifications that have improved the program. During the first year of the program, outreach language was changed based on low turnout and feedback. Participation in the program has increased since then. Initially, data were collected on every detail of the site visits. Later, some of the data were determined to be unnecessary and collection of this information was found to be eliminating saving substantial staff time.

To improve program participation, an informal survey asked King County staff what they thought were the businesses' barriers to proper hazardous waste behavior. Cost was first on the staff's list. As a result, King County developed a program to reimburse small businesses up to $500 for money spent on hazardous waste management. However, few businesses accepted the vouchers, and even fewer turned them in for reimbursement. Direct surveys of businesses identified convenience as a more important barrier than cost. Since then, voucher acceptance has increased markedly due to increased ease of access. To date, more than 500 vouchers have been distributed.

For information regarding the Onsite Consultation Team Program or other King County programs, consult King County's Web site at *http://www.metrokc.gov/hazwaste/*.

Contra Costa Clean Water Program's Public Education Program

The Contra Costa Clean Water Program (CCCWP) is the stormwater program for Contra Costa County, Calif. The population of CCCWP's service area is approximately 1 million. One element of the CCCWP their Public Education Program, which operates on a budget of approximately $300,000.

The CCCWP conducts its Public Eeducation Program to increase awareness of stormwater pollution and change polluting behaviors. Pollutants of concern that have been identified include chorpyrifos and polynuclear aromatic hydrocarbons. The public education effort attempts to deliver a message that will motivate residents to change their behavior. Outreach messages have focused on reducing pesticide use and recycling used motor oil. Messages are

promoted through television, radio, newsletters, a newpaper, bill inserts, the Internet, bus advertising and subway placements, a billboard, and theater advertising. The *Grow It!* guide was promoted through these media. A guide on car maintenance — *Keeping It All in Tune* — was also advertised. Other items related to used motor oil recycling have included funnels and advertisement of recycling locations.

The CCCWP measures awareness of the overall program and collects information on attitudes and behavior through an annual public opinion survey. Other evaluation efforts include focus groups and a pilot study. Costs associated with evaluation include $20,000 to $25,000 for the annual public opinion survey, $20,000 to $25,000 to conduct four focus groups (north, south, east, and west), and $11,500 for the evaluation of the high school pilot study.

The CCCWP has used the information from the public opinion survey to identify effective outreach methods and to help plan future public education activities. Quantitative survey results are considered along with the focus group results previously discussed when making decisions on future directions of the public outreach program.

Just like the quantitative surveys conducted by other programs, this survey is conducted by interviewing 400 adults living in Contra Costa County by telephone using random dialing. Questions are asked in the following areas:

♦ Awareness of environmental issues in general and with respect to water pollution in particular;
♦ Understanding of storm drain systems, and who are significant contributors of water pollution;
♦ Which household products are commonly used (that is, motor oil, pesticides, and paints) and practices associated with use and disposal of these products;
♦ Awareness of outreach messages regarding stormwater;
♦ Attitudes/willingness to change their behavior with respect to pollution generating practices; and
♦ Willingness to pay additional taxes to help prevent stormwater pollution.

A survey analysis summarized the results of the survey and also evaluated the behavior and attitudes of different groups. Thus, recommendations could be made on how to best target future outreach. Conclusions/recommendations from the 1998 public opinion survey included the following:

♦ Contra Costa County residents are not overwhelmingly concerned about water pollution. Therefore, education campaigns should focus on increasing the frequency with which information is seen or heard within the limits of the program's available budget.
♦ While knowledge regarding the destination of the storm drain system has increased from 25% in 1994 to 37% in 1998, there is still a tremendous opportunity to educate residents about the storm drain system and the impacts of improper pollutant disposal. These efforts should target females who are more than twice as likely as males to be uninformed about these issues.
♦ Information specifically designed to change environmentally harmful behavior should be targeted to high-risk groups that continue to dispose of hazardous products inappropriately. The survey found that disposal of paint products, fertilizers, pesticides, and oil filters were occurring in environmentally harmful ways. Survey results indicated that outreach regarding improper disposal should target non-Whites under the age of 40. Efforts to encourage recycling and composting should target younger, less-

educated, and less-affluent residents. Similarly, certain behaviors were associated with geographic areas within Contra Costa County, indicating that certain outreach efforts should target certain geographic areas.

♦ Contra Costa County residents are comfortable with the current average tax rate of $25 to prevent stormwater pollution. Efforts to raise taxes should focus on education, improving drinking water quality, and the environment for fish and wildlife rather than improving recycling programs or treating stormwater.

♦ Contra Costa County residents would be interested in hiring environmentally certified contractors, but may not be willing to pay more for them. Efforts to educate residents about the benefits of hiring environmentally certified contractors should target men, homeowners, and those earning more than $45,000 annually.

The public opinion survey is quantitative, statistically significant, and allows cross tabulations to assess attitudes and behaviors in different sectors of the population. This allows public education efforts to target specific audiences as appropriate. The CCCWP has found it useful to coordinate the survey's findings with focus group results. While the focus groups are not quantitative, they provide more descriptive information that can help support and expand the usefulness of the survey's findings.

Los Angeles County Stormwater/Urban Runoff Public Education Program

As part of the 1996 NPDES permit for Los Angeles County, a comprehensive educational stormwater and urban runoff outreach approach was mandated to reach as many Los Angeles County residents as possible. The goals of the program are to measurably increase target audiences' knowledge of the impacts of stormwater pollution and to measurably change their behavior by encouraging appropriate solutions. The program includes anecdotal, qualitative, and quantitative measurements to assess effectiveness.

A precampaign segmentation study was conducted to prioritize audiences and activities to target those most likely to pollute. This study identified target audiences who would also be the most likely to adopt behavioral changes and could be reached in a cost-effective manner. Based on the results of the segmentation study, the public outreach program was designed to reach:

♦ The general public identified as wanting "to do the right thing;"

♦ "Do-it-yourselfers;" and

♦ A harder-to-reach, younger, and rebellious segment of the population that was found to be motivated by actions that would protect children or water sports areas.

The segmentation study indicated that the largest target audience — the segment of the general public that intends to do the right thing — gets most of its instructional information from mass media. Newspapers, radio, and billboards are used as the three key sources to disseminate program information. To a lesser degree, the outreach program also uses public service announcements, instructional materials, corporate and entertainment industry tie-ins, displays, community events, a speakers and experts bureau, and an existing hotline number.

The segmentation study was a major research undertaking. Several hundred people throughout Los Angeles County were interviewed by telephone and asked a series of questions designed to identify the following:

♦ Characteristics that allowed researchers to determine "segments" of the population (groups with common profiles);

- How much different segments of the population pollute stormwater and urban runoff (knowingly or unknowingly);
- How much of an effort it would take to motivate the different segments of the population to make changes that would clean up runoff pollution; and
- The key motivating factors for each segment.

The segmentation study identified the following:

- Top candidates for outreach because they pollute and generally are willing to change their behavior: people who want to do the right thing; do-it-yourselfers; and young men (late teens and early twenties) who are generally rebellious and tend to "trash" (to the surprise of researchers, this group was found to have a "soft spot" for kids).
- Poor candidates for outreach because they already do the right thing: people who are middle age or older, are avid recyclers, and identify themselves as being environmentally responsible. These individuals were considered poor candidates for outreach because they basically have no bad behaviors to change.
- Poor candidates for outreach because of the level of effort it would take to motivate them to change behaviors: people who will not change unless Los Angeles County "proved" the need, and people who are so "down and out" that they are focused on basic life needs such as a job, food, and shelter. (The segmentation study also indicated that people who are down and out typically do not pollute stormwater.)

At $100,000, the segmentation study was somewhat costly and may only be applicable for public education programs with large population centers. More specifically, the segmentation study is a good tool to help education program managers prioritize their outreach/education efforts to the target audiences that will produce the greatest results.

Los Angeles County's Public Education Program also uses traditional telephone surveys and focus groups to determine base line data about awareness and behaviors. These same research methods will be used to evaluate changes in awareness and behaviors that should indicate the effectiveness of the outreach being conducted.

The segmentation study was one of the most important components of Los Angeles County's 5-year public education plan. Nearly all strategies in the 5-year plan were designed to target segments of the population that the study showed would produce the greatest results in terms of reducing pollution.

To assess overall effectiveness of the targeted outreach/education efforts, research will be conducted at the 3-year (1999) and 5-year (2001) marks. Quantitative studies will also be conducted for the general public/residents at years 3 and 5 and for businesses (for example, automobile repair, restaurant, and construction) at year 5 only. The studies will have components to assess why and how the program is working to help refine and improve the program over the life of the plan. Other anecdotal qualitative and quantitative measurements will be implemented periodically to assess effectiveness among specific audiences in different media channels.

EnviroStars, King County LHWMP

Evaluation data at the 3- and 5-year marks will be collected through a telephone survey of men and women (16 years of age and older) who have been residents of Los Angeles County for at least 6 months. Analysis of the data will include correlating the information gathered against the benchmark established in the precampaign segmentation study.

EnviroStars is a business recognition program for hazardous waste prevention. The program's goals are:

♦ To use positive recognition as an incentive for small businesses to prevent hazardous waste generation and pollution,
♦ To provide examples for other businesses,
♦ To increase consumer awareness and influence purchasing decisions based on responsible environmental practices in King County businesses, and
♦ To provide a tool that field staff can use to bring about lasting waste prevention changes.

Based on a two- to five-star rating scale, the more proactive and comprehensive a business's practices, the more recognition it will receive. The rating system gives consumers an objective way to evaluate business environmental practices, and promoting EnviroStars' responsible practices helps them to attract new customers, reinforce repeat customers, and boost employee morale in addition to affecting long-lasting pollution prevention changes in King County businesses. Program requirements include being located in King County, not being a fully regulated generator of hazardous waste, setting an annual waste reduction goal, participating in a site visit, and filling out a worksheet on waste prevention opportunities (for more than two stars). The worksheet helps businesses think through their activities with pollution prevention in mind and to detail the waste reduction steps they have already taken. The worksheet also establishes a written goal that commits the business to an ongoing improvement process.

Introduced in 1995, the EnviroStars program targets businesses in King County that generate small amounts of hazardous waste (that is, auto body and repair shops, printers, dry cleaners, machine shops, manufacturers, dentists, laboratories, and so on). There are an estimated 45,000 potential businesses in the target audience. In 1997, 92 site visits were conducted and 38 business became EnviroStars. Two business groups that were targeted that year were dental offices and automotive facilities. Effective outreach to each of these groups has been realized largely by working through the groups' industry associations, leaders, and publications. Approximately 85% of the county's dentists belong to the local dental society and 20% to 30% of vehicle service facilities belong to their trade association. Thirteen businesses from each group were recognized as EnviroStars in 1997. By early 1999, 38 EnviroStars (25% of the total) were dentists and 61 EnviroStars were vehicle service facilities (41% of the total). There were a total of 102 EnviroStars at the end of 1997 and 150 at the end of 1998.

An incentive that proved effective in getting businesses to participate in EnviroStars was to include them in the 1998 Signs of a Green Business Directory. A commonly mentioned reason for business participation is that "it is the right thing to do." Early in the program (1996), public awareness of EnviroStars was assessed as part of a King County random telephone survey of 400 county residents. The survey indicated that 4% of the respondents were aware of EnviroStars. Of those respondents, 27% heard about EnviroStars through the radio, 20% through the newspaper, 7% through bus advertisements, and 27% did not remember where they had heard of it.

Businesses receive a two- to five-star rating and corresponding recognition depending on the level of participation in the project, as summarized in Table A-6.

Table A-6. EnviroStars Recognition Levels

Number of stars	Requirements	Recognition	Number at this level in 1998
2	Properly manage hazardous waste and set a waste reduction goal.	• Certificate • Window sticker • Logo for marketing use	14
3	Above plus identify ways that waste has been reduced in cleaning practices, product and waste storage, purchasing and inventory management, and employee involvement.	Above plus ▪ Highlighted in radio ads ▪ Featured in special promotions	55
4	Above plus show how hazardous waste prevention is built into operations, marketing, management and accounting systems.	Above plus • Success story profile sent to local papers • Nomination for WIN award	44
5	Above plus demonstrate proactive leadership/ commitment to preventing waste and spreading education of environmental responsibility, solid waste recycling and purchasing recycled products.	Above plus A- Recognition as Green Works member B- Governor's Award nomination	33

In 1998, 1.2 full-time equivalent (FTE) (that is, 1.2 persons working 40 hours per week or full time) of staff time and approximately $80,000 for materials and marketing was used for the EnviroStars program. The program has been expanded to include three neighboring counties and other regional business recognition programs. Although this collaboration is labor inten-sive, it is important to help ensure a uniform approach and message.

Western Lake Superior Sanitary District Zero-Discharge Pilot Project — Dental Program

Western Lake Superior Sanitary District (WLSSD) is the largest wastewater treatment facility discharging into the Lake Superior watershed. The treatment plant has an average daily flow of 43 Mgal/d and serves a population of 130,000. WLSSD is working to meet a mer-cury effluent limit of 0.03 μg/L specified in their NPDES permit. WLSSD supports a goal of zero discharge of persistent bioaccumulative toxics within the Lake Superior basin. WLSSD has made a commitment to achieving zero discharge of persistent toxic substances, such as mer-cury, lead, dioxins, polychlorinated biphenyls, and hexacholorobenzene, and has assigned four full-time staff and an annual budget of $300,000 to the program.

The WLSSD staff believes that achieving zero discharge is a stepwise process that can be approached by working with customers to eliminate the use of mercury. The goal of this pilot project was to develop an integrated multimedia program to reduce the discharge of mercury using front-end pollution prevention techniques targeted at specific customers, and to share the successes and failures of this pilot project with other interested parties. One of the projects within the program targets dental offices.

WLSSD developed their dental program by working with the local dental association. Meet-ings with leadership of the Northeast District Dental Society (the local professional group) were invaluable in obtaining a cursory understanding of their profession and the problems they face in managing their wastes. WLSSD staff approached the Northeast District Dental Society and suggested that they work together to raise awareness in the dental profession to keep mercury out of the wastewater. Cooperation between WLSSD staff and the dental society has been the key to this project's success. With assistance from the dental society, WLSSD staff produced a manual

of BMP with information on proper disposal of mercury, amalgam, and other dental office wastes. This manual was distributed to all dentists in the WLSSD service area. WLSSD continues to work with the dental society to evaluate the cost of amalgam recycling, to evaluate amalgam removal equipment currently on the market, to further develop the recycling program, and to provide ongoing pollution prevention education for the dental community.

Throughout this program, evaluation has been used to plan and make modifications to the program. Evaluation during the planning process included conducting surveys, obtaining group feedback from the local dental society, and conducting base line monitoring of dental wastewater discharges. Evaluation during the project has included subsequent wastewater monitoring, waste audits, and the tracking of mercury collected as a result of these programs.

As part of the planning process, a survey was designed to determine practices of the dental profession with respect to waste generated in the everyday operation of the office, with a specific emphasis on mercury/silver amalgams. Development of the survey was greatly enhanced by the assistance of leadership from the Northeast District Dental Society. A list of 89 dentists' addresses was obtained, and surveys sent to them on July 22, 1992. On the deadline date of August 10, 1992, 52 dentists had responded for a return rate of 58%.

In 1993, WLSSD staff sampled the wastewater discharge from a medical building housing several dental practices and found a mercury concentration of 35 ppb. This represented approximately 0.3 g of mercury discharged by each dentist each day. Subsequent monitoring of the same building in 1995 found the effluent mercury concentration reduced to 0.086 g of mercury per dentist per day. This reduction was attributed to the outreach program as well as changes in waste handling practices at the dental offices. It is estimated that the mercury concentration in the wastewater discharge from dental clinics in the WLSSD service area was reduced from an estimated 16 g/d in 1993 to 5 g/d in 1995.

In 1995, WLSSD staff returned to the dentists to conduct waste audits. These audits disclosed that while amalgam waste captured in chair-side traps and vacuum pump traps was no longer being disposed of down the drain, it was still being placed in the solid waste or medical waste container. Solid waste is burned at the WLSSD facility and medical waste is routinely incinerated in Minnesota, so this disposal practice still created mercury pollution. As a result, WLSSD staff worked with medical waste contractors in the region and a mercury recycling firm to set up a pilot program to collect chair-side traps for recycling. This program was announced in September 1996 and an accompanying insert for the manual was distributed through the Northeast District Dental Society. As a result of the dental office audits, it was learned that the infrastructure was not available for properly managing the mercury-containing waste. Amalgam waste was being placed in the solid waste or medical waste stream and only rarely recycled or managed as hazardous waste.

As a result of the mercury audits, the most important needs that were identified were to:

♦ Improve waste management practices for chair-side traps and vacuum pump traps,
♦ Improve the infrastructure for managing the mercury-containing waste, and
♦ Increase the amount of amalgam captured in the vacuum system in order to reduce the quantity of amalgam particles discharged to the sewer.

In order to address these needs, WLSSD presented its findings to local dental organizations and formed an environmental committee composed of WLSSD staff and representatives

from the Northeast District Dental Society. Elements added to the dental program as a result of these more recent joint efforts include the following:

♦ ***Increased recycling*** — The committee identified three options to encourage area dentists to increase the amount of mercury recycled. Dental amalgam could be delivered to the WLSSD Clean Shop Program (a program to assist small businesses with hazardous waste disposal) for recycling, it could be mailed to a recycler in the Minneapolis area, or it could be picked up for recycling by a medical waste disposal provider. Medical waste disposal firms serving the Duluth area agreed to provide pick-up service. The first dental office to take advantage of the Clean Shop Program brought in scrap amalgam and amalgam from chair-side traps. In 1997, 15 participants brought in 40.4 lb of amalgam scrap and 34.86 lb of raw mercury. This is an average of 0.22 lb of waste amalgam per month per participant. Recycling this quantity of amalgam at a facility approved by the Minnesota Pollution Control Agency (MPCA) would cost less than $5 per pound per year.

♦ ***Onsite training*** — An onsite waste management training program for dental office staff was developed. District staff trained two dental assistants on proper recycling techniques and the importance of improving the management of amalgam waste. Following this training, the two dental assistants visited 50 dental offices to provide hands-on instruction to other dental workers. As a result of these site visits, WLSSD staff collected 35 lb of elemental mercury and convinced dentists to use premixed capsules instead of bulk elemental mercury. It is interesting to note that even with WLSSD's educational program, the elemental mercury was not turned in by dentists for recycling until an onsite contact was made.

♦ ***Education*** — A brochure on amalgam recycling and a manual of BMP for dental offices were produced and distributed. In addition, WLSSD staff worked with a local dentist and his assistant to prepare a slide show on amalgam recycling. This slide show was presented at the Minnesota State Dental Association's annual conference in 1997 and at other professional meetings. Articles on amalgam recycling were published in two trade publications. Professional dental organizations and MPCA became actively involved in promoting amalgam recycling throughout the state. In addition, WLSSD staff co-authored a paper with a local dentist that was submitted to *The Journal of the American Dental Association.*

♦ ***Evaluation of separation units*** — In order to meet the need to increase the amount of amalgam separated from the vacuum pump system, the WLSSD evaluated the effectiveness of four different amalgam-separation units. WLSSD staff measured the mass of mercury discharged from dental offices before and after a treatment system was installed. Where possible, the mass of mercury captured by the treatment unit was also measured directly. The results indicated that sedimentation chambers can capture more than 99% of the mercury not captured by the chair-side traps. Sedimentation chambers may be an effective, low-cost means of reducing the amount of amalgam discharged to sewers.

WLSSD has spent approximately $150,000 over the last 5 years on dental programs. Approximately $10,000 was spent on staff time to attend dental association meetings, produce manuals, conduct audits, and develop educational materials. Approximately $15,000 to $20,000 was spent on printing, the purchase of some sedimentation systems, and disposal of mercury waste. Approximately $2,000 was spent on hiring two dental assistants to conduct onsite

training for amalgam recycling. The remaining costs were associated with developing a working relationship with local dentists, the state, and local associations.

King County Hazardous Waste Management Program, Pesticide Awareness Program/ Natural Lawn Care Project

In 1992 and 1994, King County conducted a hazardous waste survey that included questions on pesticide use. Survey results indicated that more people use pesticides on their lawn than anywhere else (for example, 57% in the 1994 survey). In 1993, it was estimated that pesticides accounted for 5% of the waste stream at local household hazardous waste collection sites and 25% of the disposal cost (that is, more than $1 million). Therefore, an outreach campaign was launched to reduce residential pesticide use and future disposal costs. The targeted audience for these campaigns was suburban homeowners more than 30 years of age with incomes over $50,000. This group was determined to be the highest pesticide users in the Seattle–King County area. Specific objectives of the Pesticide Awareness Program were to increase awareness regarding the overuse of pesticides, increase awareness of potential health effects of lawn care pesticides, and encourage the reduced use of pesticides.

The following outreach strategies were included in an advertising campaign from 1994 to 1996:

♦ Radio advertisements, which ran on seven stations from April to June 1994; on eight stations for 12 weeks (April to June) in 1995; and on eight stations for 10 weeks (April to June) in 1996;
♦ Bus advertisements, which ran on 60 buses from April to July 1994; on 110 buses for 3 months (April to July) in 1995; and on 115 buses mainly traveling to the area with the targeted audience for 10 weeks (April to June) in 1996; and
♦ Promotional announcements, brochure distribution, and other assistance by local radio stations.

The following evaluation methods were used from 1994 to 1996:

♦ Telephone surveys were conducted before and after the advertising campaign in which people were asked the likelihood of their using pesticides on their lawn and garden during the year;
♦ Hazards Line calls were tracked; and
♦ Surveys were mailed to people calling the Hazards Line.

In 1997 and 1998, the program was changed to focus on lawn care. The Natural Lawn Care Project aimed to reduce the use of pesticides and water and increase the use of mulch and mowing. As such, the following outreach strategies were used:

♦ Radio advertisements,
♦ Television advertisements (1998 only),
♦ Door-hanger brochure (1997 only),
♦ Workshops,
♦ Utility bill inserts
♦ Toll-free telephone line, and
♦ Media outreach (media events, press releases, and radio interviews).

In 1997 and 1998, the following evaluation methods were used:

♦ Telephone surveys conducted before and after the campaign of 400 randomly selected people and
♦ In 1997, focus groups targeting men between the ages of 25 and 54 who care for their lawn at their single-family home.

Evaluation Results

The results of the before and after telephone surveys conducted from1994 to 1996 are shown in Table A-7, which lists the percentage of respondents who said they were likely to use pesticides or herbicides on their lawn this year.

Table A-7. Pesticide Awareness Program Results

	Before Ad Campaign	After Ad Campaign
1994 overall	50	55
1994 $40K - $60K income	62	50
1994 >$60K income	72	62
1995 overall	49	43
1996 overall	51	38

In 1994, there was no change or only a slight increase in the overall responses. However, in the targeted income brackets there was a decrease in the likelihood that respondents would use pesticides after the advertising campaign. In subsequent years, there was also a decrease seen after the advertising campaign. The procedure of recalling the advertisements after one month was also evaluated each year. Approximately 22% to 24% of respondents remembered the advertisements, with more people remembering the radio advertisements than the bus advertisements. The number of calls to the Hazards Line regarding pesticides ranged from 75 (in 1995) to 586 (in 1994).

Results from the 1994 to 1996 campaign were used to develop the Natural Lawn Care Project in 1997 to 1998. The results were also used to modify messages used from year to year. During the Natural Lawn Care Project, 1997 focus group results were used to develop messages and strategies for 1998, with an emphasis placed on the "how" and "why" of changing lawn care practices. Some results from surveys conducted in 1997 and 1998 are shown in Table A-8.

Table A-8. 1997 to 1998 Natural Lawn Care Project Results

Attitudes	April 1997	August 1998
Don't care about lawn weeds	7%	14%
Want a weed-free lawn	27	9
Leave grass clippings on lawn	45	56
Never water lawn in summer	18	23
Important that next mower mulches	33	42
Concern over lawn care impact on environment	64	64

These survey results indicate that advertising media campaigns have been effective in changing attitudes. In addition, the advertisements were memorable. In 1997, approximately 36% of people surveyed recalled the advertisements and approximately 25% recalled one or more messages that were used.

A colorful lawn brochure was distributed as a door hanger in 1997. Approximately 24% of people contacted by a telephone survey recalled the brochure and 12% strongly recalled it. Of those who recalled the brochure, 80% read it and 76% found it useful. Approximately 6% to 20% of survey respondents changed at least one lawn care practice because of the brochure.

The focus groups in 1997 had a positive reaction to the natural lawn care advertisements, but wanted specific reasons why they should change their practices as well as information on alternatives.

Costs associated with the Pesticide Awareness Program are shown in Table A-9. Evaluation costs were associated with the number of questions asked in the monthly polls. Fewer questions were asked in 1996 than in 1994 or 1995. Two different firms in the King County area conduct monthly polls from which it is possible to purchase questions. This reduces the expense of using them.

Table A-9. Costs Associated with Evaluation and Program Implementation

	Total budget	Evaluation budget
1994	$75,415 (65K for media buys)	$3300
1995	$87,594 (66K for media buys)	$2800
1996	$66,445 (57K for media buys)	$1000

Sacramento, Calif., Stormwater Program, Copper Control Measures Plan

The Sacramento Stormwater Program used the framework presented in this report to develop a plan to address sources of copper in stormwater. The identified copper sources, in approximate order of priority, include

- ◆ Pesticide use,
- ◆ Rainfall/atmospheric deposition,
- ◆ Tap water,
- ◆ Automotive brake pad wear,
- ◆ Metal recyclers,
- ◆ Tire wear,
- ◆ Metal finishers,
- ◆ Cooling towers,
- ◆ Construction site runoff.
- ◆ Automobile dismantlers,
- ◆ Airports,
- ◆ Swimming pools, and
- ◆ Food product manufacturers.

In addition to these sources, a source identification study evaluated parking lots and highways. Although these latter entities are not considered to be sources, they do represent stormwater conveyances or pathways for pollutants from vehicle-related sources (that is, brake pads and tires). These pathways may serve as points of control for vehicle-related sources.

To prioritize these sources, Sacramento used many of the same participation and loading factors used by Palo Alto, but also developed estimates for some additional strategies associated with their project.

A participation rate of 50% was assumed for businesses with minimal previous contact with the Sacramento Stormwater Program (for example, cooling tower discharges and pool maintenance companies). Business participation/cooperation was assumed to be 80% for those businesses already involved in stormwater programs (for example, metal recyclers, automobile dismantlers, construction, and street sweeping).

Automotive brake pad wear and atmospheric deposition were two additional copper sources identified by Sacramento. Strategies to address these sources were beyond the jurisdiction of the Sacramento Stormwater Program. The participation rate for a regional/national strategy, such as working with the Air Board or the Brake Pad Partnership, was difficult to estimate. The audience for Air Board-related outreach is the general public. Therefore, this control measure was assumed to have the same participation rate as a difficult-to-implement public education campaign (5%). The audience for the Brake Pad Partnership is brake pad manufacturers. Therefore, this control measure was assumed to have the same participation rate as a difficult-to-implement business outreach program (30%).

Control measures associated with the New Development Management Program (that is, strategies to reduce impervious area in parking lots) were assumed to be difficult to implement and were assigned a low participation factor (5%). Control measures targeting existing parking lots (that is, sweeping, employee education, and so on) were assumed to be similar to public outreach in their potential effectiveness (10%).

Loading factors associated with stormwater activities were also estimated. Programs associated with nonstormwater discharges would have a 100% loading factor because the entire source would be eliminated by 100% participation. The loading factor for structural controls would be the estimated removal efficiency of the control. For all the structural BMP, information on removal efficiencies showed a wide range. An average removal efficiency of 50% was used for structural controls (that is, swales, inlet filters, and so on). For measures relating to good housekeeping and employee training, a loading factor of 80% was also used based on the fact that less material would find its way to the storm drain rather than no material going to the storm drain. Loading factors for new development activities were based on the potential reduction of impervious surfaces (3% to 5%) based on studies conducted by the City of Olympia, Wash., in 1995. Loading factors for improved tire maintenance and brake pad reformulation were 25% and 80%, respectively, based on an estimated reduction in copper from implementation of these measures rather than a complete elimination of copper.

Results

Table A-10 shows the estimated participation and loading factors and the resulting load reduction for each control strategy for Sacramento. Available cost information for the control strategies is shown in Table A-11. Sacramento also assessed the controllability of copper sources. Figure A-3 presents the relative controllability of the identified sources by the Comprehensive Stormwater Management Program (CSWMP). In addition, Sacramento evaluated the control strategies with respect to their applicability to other pollutants of concern identified by the stormwater program. Airports, automobile dismantlers, metal recyclers, and tire wear were all identified as sources of lead (another CSWMP pollutant of concern). Control measures targeting vehicle trip reductions, parking lots, and streets and highways also have the potential to address all vehicle-related sources of several pollutants of concern.

Table A-10. Estimated Control Measure Effectiveness

Source	Max. Load (lb/year)	Conc. (µg/L)	Control Strategy	Audience Partici-pation Factor	Load factor	Effective-ness Rating	Estimated Reduction (lbs/yr)
Vehicle Related	5900		Work w/ Air Board -ride sharing	5%	50%	3%	148
Brake pad wear	5900		Brake Pad Partnership	30%	80%	24%	1416
Parking Lots	2900		Employee education	10%	80%	8%	232
			Inlet Filter Inserts	5%	50%	3%	73
			Grass Swales	5%	50%	3%	73
			Swale Sand Filter Combination	5%	50%	3%	73
			Inlet cleaning	5%	80%	4%	116
			Street Sweeping	80%	3%	2%	70
			Stencils/ signs	10%	10%	1%	29
			Cooperative Parking	5%	5%	0.3%	7
			Reduced parking ratios	5%	5%	0.3%	7
			Hybrid Lots	5%	5%	0.3%	7
			Alternative Pavements	5%	5%	0.3%	7
Streets and Highways	1168		Narower residential streets	5%	3%	0.2%	2
			Track CalTrans Activities			N/A	
Metal recyclers	135	1010	Existing Programs, lead BMPs	80%	80%	64%	86
Tire wear	1003		Public Education on Tire maintenance	10%	25%	3%	25
Cooling tower discharges	75	223	Redirect to Sanitary sewer	50%	100%	50%	38
Metal Finishers	5	301	Industrial BMPs	50%	80%	40%	2
Construction site runoff	605		Existing Programs	80%	80%	64%	387
Auto dismantlers	156	103	Existing Programs, lead BMPs	80%	90%	72%	112
Airports		91	Lead BMPs, no vehicle washwater	100%	100%	100%	91 µg/L

Table A-11. Control Measure Cost Information

Source	Max. Load (lb/year)	Conc. (µg/L)	Control Strategy	Annual Cost	Source of Information or Basis for Estimate
Costs to Stormwater Program					
Vehicle Related	5900		Work w/ Air Board -ride sharing	?	
Brake pad wear	5900		Brake Pad Partnership	$5,000-$10,000/yr	Liz O'Brien, Sustainable Conserv.
Tire wear	1003		Public Education on Tire maintenance	$10,000	Cost to produce a brochure
Streets and Highways	1168		Track CalTrans Activities	?	
Metal recyclers	135	1010	Existing Programs, lead BMPs	existing program, no additional cost	
Cooling tower discharges	75	223	Redirect to Sanitary sewer	$5000?	Modify and produce existing outreach
Metal Finishers	5	301			
Construction site runoff	605		Existing Programs	existing program, no additional cost	
Auto dismantlers	156	103	Existing Programs, lead BMPs	existing program, no additional cost	
Airports		91	Lead BMPs	existing program, no additional cost	
Costs to businesses					
Parking Lots	2900		Employee education	1-4 hrs/employee	Woodward-Clyde, 1996.
Parking Lots	2900		Inlet Filter Inserts	$100 - $5000	Woodward-Clyde, 1996.
Parking Lots	2900		Grass Swales	$5-15/linear foot	Woodward-Clyde, 1996.
Parking Lots	2900		Swale Sand Filter Combination	$5-20/sq.foot.	Woodward-Clyde, 1996.
Parking Lots	2900		Inlet cleaning	~$250/inlet	Woodward-Clyde, 1996.
Parking Lots	2900		Street Sweeping	?	
Parking Lots	2900		Stencils/ signs	~$1500 inital cost	Woodward-Clyde, 1996.
Parking Lots	2900		Cooperative Parking	(2)	City of Olympia, 1995.
Parking Lots	2900		Reduced parking ratios	(2)	City of Olympia, 1995.
Parking Lots	2900		Hybrid Lots	see alt. pavements	
Parking Lots	2900		Alternative Pavements	Asphalt: $414/stall vs. Pavers: $717/stall (1)	City of Olympia, 1995.
Streets and Highways	1168		Narower residential streets	Savings - $525/residential lot	City of Olympia, 1995.

Type of Source	Controllability by Stormwater Program (high------------low)	Information Needs
Pesticide use	------------?-----------	High-use site runoff data
Rainfall/atmospheric deposition	------------?-----------	Sacramento rainfall/dryfall data
Tap water	------------?-----------	Outside tap water data
Automotive brake pad wear	---------------X---------	
Metal recyclers	-X----------------------	
Tire wear	---------------X---------	
Metal finishers	-X----------------------	
Cooling towers	-X----------------------	
Construction site runoff	-X----------------------	
Food product manufacturers	-X----------------------	What type of activities may impact stormwater?
Automobile dismantlers	-X----------------------	
Airports	-X----------------------	
Swimming Pools	----------X-------------	
Parking Areas	--------------X---------	
Streets	--------------X---------	
Highways	----------------------X-	

? indicates that more information is needed about the source to make an assessment of its controllability.

Figure A-3. Estimated Controllability of Copper Sources by CSWMP

Based on the assessment described in Figure A-3, the following conclusions were drawn with respect to controlling copper sources:

♦ Copper-containing pesticides, rainfall, and outside tap water were identified as top priority sources. Insufficient information is available to adequately assess these sources. Therefore, acquisition of additional monitoring data is necessary to further evaluate these sources.

♦ The following control measures were identified as the most effective based on the estimated reductions shown in Table A-10 (potential reductions for these measures were greater than 100 lb/yr):
— Participating in Brake Pad Partnership;
— Continuing New Development Management Program requirements for permanent, onsite BMP (includes combined effects of multiple structural controls);
— Conducting employee education with respect to parking lot maintenance;

- Conducting parking lot inlet cleaning;
- Controlling construction-site runoff; and
- Controlling runoff from automobile dismantlers.

- While incomplete information is available with respect to costs of implementing control measures, the least expensive measures appear to be supporting existing industrial and construction-site programs and modifying existing outreach materials for prohibiting nonstormwater discharges from cooling towers.
- The cost of participating in the Brake Pad Partnership may vary, but potential reductions as a result of this control measure are an order of magnitude higher than the estimated reductions for any other control measure.

As a result of the analysis, Sacramento determined that the following control measures or information-gathering activities should be pursued:

- Conduct monitoring for pesticides, rainfall, and tap water;
- Participate in the Brake Pad Partnership;
- Continue to implement existing programs and/or develop new programs targeting parking lots;
- Cooperate with the California Air Resources Board with respect to Ride Share and Reduced Vehicle Use outreach programs; and
- Where appropriate, continue and expand existing construction site and industrial program control measures.

REFERENCES

Brosseau, G. (1997) 1997 summary report — vehicle service facility waste minimization program. Prepared for the Regional Water Quality Control Plant, Palo Alto, California.

City and County of San Francisco, Department of Public Works, Bureau of Environmental Regulation and Management (1996) *Water pollution prevention program annual report fiscal year 1995-96.*

City and County of San Francisco, Public Utilities Commission, Bureau of Environmental Regulation and Management (1998) *Water pollution prevention program 1997-98 annual report.*

DeBra, J. November 1998. Personal communication.

Dickey, P. (1995) An analysis of household cleaners and pesticides sales in Seattle/Tacoma grocery stores. Prepared for the Local Hazardous Waste Management Program in King County, Washington.

Environmental Hazards Management Institute (1997) *Guide to effective methods for increasing home composting awareness and participation rates.* At *http://www.ehmi.org/research/.*

Frahm, A. (1994) Evaluation of education: what we're doing and what we've learned. Paper presented at the Ninth National Conference on Household Hazardous Waste Management, Austin, Texas.

Gensler, G. 11 February 1999. Personal communication.

Godbe Research & Analysis (1998) Contra Costa clean water program public opinion survey. Conducted for Merritt Smith Consulting.

Harris, C. 8 February 1999. Personal communication.

Holweg, K.S. (1997) *Are we making a difference? Lessons learned from VINE program evaluations.* North American Association for Environmental Education.

Hunter, R. 21 October 1998. Personal communication.

JD Franz Research (1997) Contra Costa clean water program – 1997 focus groups.

Kehoe, P. January 1999. Personal communication.

King County Department of Natural Resources (1997) 1997 annual report for the onsite consultations program.

King County Department of Natural Resources (1998) Onsite consultations team 1998 performance objectives.

King County Local Hazardous Waste Management Program (1995) In-house evaluation. Education/Advertising Campaign, Pesticides and Paint.

King County Local Hazardous Waste Management Program (1996) In-house evaluation. Education/Advertising Campaign, Pesticides and Paint.

King County Local Hazardous Waste Management Program (1998) Flashpoint.

Kobayashi, A. December 1998. Personal communication.

Larry Walker Associates (1996) *Assessment of long term effectiveness of the Sacramento comprehensive stormwater management program.* Sacramento Stormwater NPDES Permit Monitoring Program.

Larry Walker Associates (1997) Mercury pollution prevention plan. Prepared for Palo Alto Regional Water Quality Control Plant.

Larry Walker Associates (1998) Technical memorandum: copper control measure identification. Sacramento Stormwater Monitoring Program. Prepared for Sacramento Comprehensive Stormwater Management Program.

Larry Walker Associates (1999) Surface cleaner control guideline development for Bay Area POTWs. Prepared for the San Francisco Bay Area Pollution Prevention Group.

Los Angeles County, Department of Public Works (1997) Stormwater/urban runoff public education program, 5-year public education plan. Prepared by Rogers & Associates, Harris & Company, and Pelegrin Research.

Mecum, K. December 1998. Personal communication.

Mendoza, J. February 1999. Personal communication.

Merritt Smith, A. January 1999. Personal communication.

Moran, K. 23 October 1998. Personal communication.

Ng, G. December 1998. Personal communication.

Palo Alto Regional Water Quality Control Plant (1994) Silver reduction pilot program.

Palo Alto Regional Water Quality Control Plant (1997) Clean Bay plan.

Palo Alto Regional Water Quality Control Plant (1998) Car wash coupon fact sheet.

Public Research Institute, San Francisco State University (1992) Best management practices public awareness survey. Prepared for the San Francisco Department of Public Works.

Public Research Institute, San Francisco State University (1994) Educating the public about the use and safe disposal of household toxic products: a survey of San Francisco households. Prepared for the San Francisco Department of Public Works Water Pollution Prevention Program.

Water Environment Research Foundation

Public Research Institute, San Francisco State University (1996) Educating the public about the use and safe disposal of household toxic products: a survey of San Francisco households. Prepared for the San Francisco Department of Public Works Water Pollution Prevention Program.

Public Research Institute, San Francisco State University (1998) Survey of San Francisco households. Prepared for the San Francisco Public Utilities Commission Water Pollution Prevention Program.

Selfridge, T. July 1996. Personal communication.

Slama, K. December 1998. Personal communication.

Tomchick, L. February 1999. Personal communication.

Tucker, A. 19 March 1999. Personal communication.

Tuominen, T. 13 January 1999. Personal communication.

Union Sanitary District (1995) *Annual pollution prevention plan annual report.*

Wadell, D. (1998) *Evaluating and demonstrating environmental effectiveness.* King County Department of Natural Resources.

Washington State Department of Ecology (1998) *Program evaluation.* Washington PROJECT WET Workshops (1995-1997). Report # 98-750.

Water Environment Research Foundation (1998) *Residential and commercial source control programs to meet water quality goals.* Alexandria, Virginia. Report #95-IRM-1

Weinreich, N.K. (1999a) What is social marketing? At *http://www.social-marketing.com/.*

Weinreich, N.K. (1999b) Research in the social marketing process. At *http://www.social-marketing.com/.*

Western Lake Superior Sanitary District (1998) Mercury zero-discharge pilot project — prevention at specific sources. Final Report.

Western Lake Superior Sanitary District (1999) Blueprint for mercury elimination. Success story #1. At *http://www.wlssd.duluth.mn.us/.*

Wisconsin Department of Natural Resources (1999) Wisconsin nonpoint source water pollution abatement program. At *http://www.dnr.state.wi.us/org/water/wm/nps/nps6.htm*

Water Environment Research Foundation

W E R F P u b l i c a t i o n s O r d e r F o r m

Stock #	Title (Project Number/Date Published)	Price
D0013	Guidance Manual for Polymer Selection in Wastewater Treatment (91-ISP-5/1993)	$10
D41002	Optimization of Vortex Separator Removal Efficiencies for CSO Treatment (92-TCR-2/1994)	$10
D42003	On-Line Monitoring to Control Transients in Wastewater Treatment (92-OPW-1/1994)	$10
D43007	Polymer Characterization and Control in Biosolids Management (91-ISP-5/1994)	$10
D43008	Comparison of UV Irradiation to Chlorination: Guidance for Achieving Optimal UV Performance (91-WWD-1/1994)	$10
D43014	Models for Alteration of Sediments by Benthic Organisms (92-NPS-2/1995)	$10
D44005	Selecting Biological Test Systems to Assess Time Scale Toxicity (92-BAR-1/1995)	$10
D53010	A Critical Review of Odor Control Equipment for Toxic Air Emissions Reduction (91-VOC-2/1996)	$10
D53011	Aquatic Ecological Risk Assessment: A Multi-Tiered Approach (includes software and user's manual) (91-AER-1/1996)	$10
D53015	Biofiltration: Controlling Air Emissions Through Innovative Technology (92-VOC-1/1997)	$10
D53016	Framework for a Watershed Management Program (93-IRM-4/1996)	$10
D72001	A Comprehensive UAA Technical Reference and User's Guide (91-NPS-1/1997)	$10
D72002	Defining Biosolids Stability: A Basis for Public & Regulatory Acceptance (94-REM-1/1997)	$10
D72005	Residential & Commercial Source Control Programs to Meet Water Quality Goals (95-IRM-1/1997)	$10
D72006	Toxic Organic Compounds: Fate and Biodegradation in Aerobic Systems (92-TFT-2/1997)	$10
D73001	Benchmarking Wastewater Operations: Collection, Treatment, and Biosolids Management (96-CTS-5/1997)	$10
D80000	Toxic Chlorinated Compounds: Fate & Biodegradation in Anaerobic Digestion (91-TFT-3/1998)	$10
D82001	Watershed-Scale Ecological Risk Assessment (93-IRM-4A/1998)	$10
D83001	Whole Effluent Toxicity Testing Program: Evaluation of Practices and Implementation (94-HHE-1/1998)	$10
D83002	Modeling the Stripping and Volatilization of VOCs in Wastewater Collection and Treatment Systems (91-TFT-1/1998) TOXCHEM Model Software: Call for Price Quality Assurance Program: $10 (D87001)	$10
D83003	A Framework for Assessing Time-Scale Effects of Wet Weather Discharges (92-BAR-1/1998)	$10
D83004	Biosolids Management: Assessment of Innovative Processes (96-REM-1/1998)	$10
D83005	Wet Weather Flow Management: A Research Needs Survey for Urban Areas (96-IRM-1/1998)	$10
D87000	Critical Research Needs for Understanding Ecosystem Risks from Multiple Stressors (97-IRM-3/1998)	$10
D87002	Secondary Clarifier Assessment Workshop: Research Needs and Priorities (96-CTS-7/1998)	$5
D87003	Management Issues Group Meeting Summary and Proposed Research Plan (97-WWF-1CO/1999)	$5
D93001	Urban and Highway Snowmelt: Minimizing the Impact on Receiving Water (94-IRM-2/1999)	$10
D93002	Whole Effluent Toxicity Testing Methods — Accounting for Variance (95-PQL-1/1999)	$10
D93003	Watershed Effects of Biosolids Land Application: Literature Review (96-REM-2/1999)	$10
D93004	Evaluating the Use of Constructed Wetlands in Urban Areas (92-NPS-1/1999)	$10
D93005	Evaluating Whole Effluent Toxicity Testing as an Indicator of Instream Biological Conditions (95-HHE-1/1999)	$10
D93006	Evaluating and Measuring Biosolids Incinerator Emissions (91-ISP-1/1999)	$10
D93007	Using Flow Prediction Technologies to Control Sanitary Sewer Overflows (97-CTS-8/1999)	$10
D93008	Research Priorities for Debottlenecking, Optimizing, and Rerating Wastewater Treatment Plants (99-WWF-1/1999)	$10
D93009	The Status and Use of Biocriteria in Water Quality Monitoring (96-IRM-1/1999)	$10
D93010	Protecting Workers from Exposure to Chemical and Physical Hazards at Wastewater Treatment Plants (97-HHE-3/1999)	$10
D93011	Improving Wastewater Treatment Plant Operations Efficiency and Effectiveness (97-CTS-1/1999)	$10
D93012	The Effect of Upstream Treatment Processes on UV Disinfection Performance (96-CTS-3/1999)	$10
D93014	Benchmarking Decision Criteria for Urban Wet Weather Abatement (97-CTS-6/1999)	$10
D93015	Research Needs to Optimize Wastewater Resource Utilization (98-CTS-1/1999)	$10
D93017	Understanding Fate, Transport, Bioavailability, and Cycling of Metals in Land-Applied Biosolids (95-REM-3/1999)	$10

N e w i n 2 0 0 0

Stock #	Title (Project Number/Date Published)	Price
D00300	Nitrogen Credit Trading in the Long Island Sound Watershed (97-IRM-5B/2000)	$10
D00301	Analysis and Fate of Polymers in Wastewater Treatment (94-REM-2/2000)	$10
D00302	Tools to Measure Source Control Program Effectiveness (98-WSM-2/2000)	$10
D00303	Membrane Technology: An Innovative Alternative in Wastewater Treatment (97-CTS-10/2000)	$10
D00304	Developing and Implementing a Performance Measurement System: Volume I (99-WWF-7/2000)	$10
D00305	A Review and Needs Survey of Upset Early Warning Devices (99-WWF-2/2000)	$10
D00306	Evaluating the Use of Near-Infrared Spectroscopy for the Analysis of Biosolids Constituents (99-PUM-6-ET/2000)	$10
D00307	Estimating Plant-Available Nitrogen in Biosolids (97-REM-3/2000)	$10
D00308	New Pipes for Old: A Study of Recent Advances in Sewer Pipe Materials and Technology (97-CTS-3/2000)	$10
D00309	Technology Assessments: Nitrogen Removal Using Oxidation Ditches (96-CTS-1/2000)	$10
D20001	Investigation of Hybrid Systems for Enhanced Nutrient Control (96-CTS-4/2000)	$10
D93013	Chemical Characteristics and Solids Uptake of Heavy Metals in Wastewater Treatment (includes software) (93-CTS-1/2000)	$10
D93016	Constructed Wetlands Treatment of High Nitrogen Landfill Leachate (94-IRM-U/2000)	$10

Also Available Through WERF *...

D87004	**Soil Treatability Pilot Studies to Design and Model Soil Aquifer Treatment Systems**	94-PUM-1CO	$10

*Only available to WERF subscribers.

As a benefit of joining the Water Environment Research Foundation, subscribers are entitled to receive one complimentary copy of each research report. Additional copies are available at cost (see reverse side for pricing). If you are ordering your complimentary copy of a report, please write "free" in the unit price column. Mail or fax this form along with your payment to WERF at the address below, visit our website at www.werf.org and order online, or call us at (703) 684-2470. WEF members and others, please call (800) 666-0206 to order.

Name _____ Title _____
Organization _____
Address_____
City_____ State_____ Zip Code_____ Country _____
Phone_____ Fax _____ Email _____

Stock #	Code	Publication	Quantity	Unit Price	Total

Method of Payment: *(All orders **must be** prepaid.)*

❑ Check or Money Order Enclosed

❑ Visa   ❑ Mastercard   ❑ American Express

Account No._____ Exp. Date_____

Signature_____

Postage & Handling	
VA Residents Add 4.5% Sales Tax	
Canadian Residents Add 7% GST	
TOTAL	

Postage & Handling:

Amount of Order	Continental U.S.	Canada & Mexico	All Others
Up to but not more than:	Add:	Add:	Add:
$25.00	$3.30 **	$3.95	30% of amount
50.00	4.50	6.10	
100.00	6.25	8.30	
150.00	7.50	11.90	
200.00	9.20	16.25	
250.00	11.00	22.75	
350.00	13.65	27.25	
More than $350.00	Add 4% of order	Add 8% of order	

**minimum amount for all orders
Alaska, Hawaii, and U.S. Territories: Use Continental U.S. rates plus 5% of order amount. For orders over $350.00 add 6% of order amount only.

Please send payments to:

Water Environment Research Foundation

601 Wythe Street
Alexandria, VA 22314-1994
USA
Phone: 703-684-2470
Fax: 703-299-0742
www.werf.org

FO

Water Environment Research Foundation

Subscriber List

UTILITY SUBSCRIBERS

Adrian, City of, MI
Akron, City of, OH
Alexandria Sanitation Authority, VA
Allegheny County Sanitary Authority (ALCOSAN), PA
Amarillo, City of, TX
American Bottoms Wastewater Treatment Plant, IL
Ames, City of, IA
Anchorage Water and Sewer Utilities, AK
Ann Arbor Utilities Department, MI
Anne Arundel County Department of Utilities, MD
Atlanta Bureau of Pollution Control, GA
Austin, City of, TX
Bangor, City of, ME
Broward County, FL
Butler County Department of Environmental Services, OH
Central Contra Costa Sanitary District, CA
Charleston Commissioners of Public Works, SC
Charlotte-Mecklenburg Utility Department, NC
Clackamas County, OR
Cleveland, City of, TN
Cobb County Water System, GA
Colorado Springs, City of, CO
Columbus, City of, OH
Columbus Water Works, GA
Contra Costa Water District, CA
County of Fairfax PWD, VA
Crestline Sanitation District, CA
Dallas Water Utilities, TX
Delta Diablo Sanitation District, CA
Des Moines Metropolitan Wastewater Reclamation Authority, IA
Detroit, City of, MI
District of Columbia Water & Sewer Authority (Blue Plains), Washington, D.C.
Downers Grove Sanitary District, IL
Durham, City of, NC
East Bay Municipal Utility District, CA
El Paso Water Utilities, TX
Escondido, City of, CA
Eugene/Springfield Water Pollution Control, OR
Fairfield - Suisun Sewer District, CA
Fort Lauderdale, City of, FL
Fort Wayne, City of, IN
Fort Worth, City of, TX
Fox River Water Reclamation District, IL
Frederick County DPW - Water & Sewer, MD
Gainesville, City of, FL
Generale des Eaux
Glendale, City of, AZ
Grand Rapids, City of, MI
Greater Peoria Sanitary District, IL
Green Bay Metro Sewerage District, WI
Gulf Coast Waste Disposal Authority, TX
Hampton Roads Sanitation District, VA
Henderson, City of, NV
Holland Board of Public Works, MI
Honolulu, City and County of, HI
Houston, City of, TX
Independence, City of, MO

Irvine Ranch Water District, CA
Jacksonville Electric Authority, FL
Johnson County Unified Wastewater Districts, KS
Kansas City, City of, KS
Kansas City Water and Pollution Control, MO
Kenosha Water Utility, WI
King County Department of Natural Resources (Seattle), WA
Kissimmee Water & Sewer Department, FL
Knoxville Utilities Board, TN
Lancaster, City of, PA
Lansing, City of, MI
Las Virgenes Municipal Water District, CA
Lincoln Wastewater System, NE
Little Blue Valley Sewer District, MO
Little Rock Wastewater Utility, AR
Littleton/Englewood Water Pollution Control Plant, CO
Lodi, City of, CA
Los Angeles, City of, CA
Los Angeles County, Sanitation Districts of, CA
Loudoun County Sanitation Authority, VA
Louisville & Jefferson County Metropolitan Sewer District, KY
Macon Water Authority, GA
Madison Metropolitan Sewerage District, WI
Massachusetts Water Resources Authority, MA
Mesa, City of, AZ
Metro Nashville Water Services, TN
Metro Sewer District of Greater Cincinnati, OH
Metro Wastewater Reclamation District, Denver, CO
Metropolitan Council Environmental Services, Twin Cities, MN
Metropolitan District of Hartford, CT
Metropolitan Sewer District, City of St. Louis, MO
Metropolitan Sewer District of Buncombe County, City of Asheville, NC
Metropolitan Water Reclamation District of Greater Chicago, IL
Miami-Dade Water & Sewer Authority, FL
Milwaukee Metropolitan Sewerage District, WI
Montgomery, City of, AL
Mount Pleasant Waterworks and Sewer Commission, SC
New Haven, City of, WPCA, CT
New Orleans, Sewerage & Water Board of, LA
New York City Department of Environmental Protection, NY
North Shore Sanitary District, IL
Northeast Ohio Regional Sewer District, OH
Omaha Public Works Department, NE
Orange County Public Utilities, FL
Orange County Sanitation District, CA
Orange Water & Sewer Authority, NC
Orlando, City of, FL
Owosso, City of, Department of Utilities, MI
Palo Alto, City of, CA
Passaic Valley Sewerage Commissioners, NJ
Philadelphia, City of, PA
Phoenix Water Services Department, AZ
Pine Bluff Wastewater Utility, AR
Racine, City of, WI

Reedy Creek Improvement District, FL
Richmond, City of, VA
Sacramento Regional County Sanitation District, CA
Safford Utilities, City of, AZ (Gila Resources)
Saginaw, City of, MI
Salt Creek Sanitary District, IL
Salt Lake City Corporation, UT
San Antonio Water System, TX
San Diego Metropolitan Wastewater Department, City of, CA
San Francisco, City and County of, CA
San Jose, City of, CA
San Marcos, City of, TX
Santa Rosa, City of, CA
Seminole County Public Works - Environmental Services, FL
Sheboygan Regional Wastewater Treatment, WI
South Bayside System Authority, CA
South Coast Water District, CA
Spartanburg Sanitary Sewer District, SC
St. Petersburg, City of, FL
Tallahassee, City of, FL
Tampa Sanitary Sewer Department, FL
Trinity River Authority, TX
Tulsa, City of, OK
Unified Sewerage Agency, OR
Union Sanitary District, CA
United Water Florida, FL
University Area Joint Authority, State College, PA
Upper Blackstone Water Pollution Abatement District, MA
Washington Suburban Sanitary Commission, MD
Water & Sewer Authority of Cabarrus County
Watertown, City of, WI
Wausau Water Works, WI
Wayne County Department of Environment, MI
West Palm Beach, City of, FL
Western Lake Superior Sanitary District, MN
Wheaton Sanitary District, IL
Wyoming, City of, MI

CORPORATE SUBSCRIBERS

AG-Chem Equipment Company, Inc.
Alan Plummer & Associates
Alpine Technology, Inc.
Aluminum Company of America (ALCOA)
*American Electric Power
Anglian Water Services Limited
Aquateam - Norwegian Water Technology Centre A/S
Asseau - BPR
Barr Engineering, Inc.
Bio Gro Systems (Wheelabrator, Inc.)
Black & Veatch
Boyle Engineering Corporation
Brown and Caldwell
Burns & McDonnell
CDS Technologies Pty., Ltd.
CH2M HILL
Camp, Dresser, & McKee, Inc.
Carollo Engineers, Inc.

*Chemtrac Systems, Inc.
Chevron Research & Technology Company
Clancy Environmental Consultants, Inc.
Cytec Industries, Inc.
Damon S. Williams Associates, L.L.C.
Dow Chemical Company
Earth Tech, Inc.
Eastman Chemical Company
Eastman Kodak Company
E.I. DuPont de Nemours & Co. Inc.
EMA Services, Inc.
Finkbeiner, Pettis, & Strout, Inc.
Frontier Geosciences, Inc.
Gannett Fleming, Inc.
*Golder Associates, Inc.
Greeley and Hansen
HDR Engineering, Inc.
HNTB Corporation
Hagler Bailly
Hazen and Sawyer, P.C.
Infilco Degremont, Inc.
Institute for Environmental Technology & Industry, Republic of Korea
Jacobson Helgoth Consultants
Jane Forste, LLC
Jordan, Jones, & Goulding, Inc.
KCI Technology
Kelly & Weaver, P.C.
Kennedy/Jenks Consultants
Komline Sanderson
Lawler, Matusky and Skelly Engineers, LLP
Limno-Tech, Inc.
Lyonnaise des Eaux
Malcolm Pirnie, Inc.
McNamee, Porter, & Seeley
Metcalf & Eddy
Moffa & Associates
Montgomery Watson
NCASI - National Council for Air & Stream Improvement
*Odor & Corrosion Technology Consultants, Inc. (OCTC)
Parametrix, Inc.
Parsons Engineering Science, Inc.
Post, Buckley, Schuh, & Jernigan
Procter & Gamble Company
Roy F. Weston, Inc.
Royce Instrument Corporation
Sear-Brown Group
Severn Trent Environmental Services, Inc.
Shell Oil Company
Stantec Environmental
Sverdrup Corporation
Thames Water Utilities
Tetra Tech, Inc.
The Cadmus Group
The ERM Group
The Eshelman Company, Inc.
The HACH Company
Trojan Technologies, Inc.
United Water Services LLC
URS Greiner (Woodward-Clyde Consultants)
U.S. Filter Corporation
Wade-Trim/Associates
Water Research Center (WRc, Inc.)
Woodard & Curran

*Represents New Subscribers for 2000

**Water Environment
Research Foundation**

601 Wythe Street
Alexandria, VA 22314-1994
(703) 684-2470
www.werf.org

Apr 00

D00302