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Output-Based Performance Measures for the North Carolina Office of Waste Reduction

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Final Report

March 1996

Prepared for

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SECTION 1
INTRODUCTION

The North Carolina Office of Waste Reduction (NC OWR) currently provides technical assistance, education, and training through its Pollution Prevention Program and its Solid Waste Reduction Program for industry, local government, state agencies, and citizens. An important component of the outreach efforts of the NC OWR to industry and local governments is assistance in identifying and implementing appropriate pollution prevention technologies. These technologies reduce waste output while improving economic competitiveness by improving materials and energy efficiency, reducing the costs of waste management and handling, and avoiding regulatory penalties. The apparent success of these efforts is evidenced in the formation of similar programs in other states in the U.S. Environmental Protection Agency's (EPA's) Region 4.

As with any technical assistance and technology transfer effort, assessment and evaluative feedback is essential to managing these programs effectively and supporting funding decisions. A well-designed system for performance assessment and evaluation can fill a number of management needs:

- measuring and improving customer satisfaction,
- identifying the most promising strategies and understanding why they are effective,
- rewarding and reinforcing positive results,
- allocating resources to their most effective use, and
- demonstrating accountability and value to program sponsors.

The design of an evaluation plan is especially critical in public institutions. Sponsors of public programs demand measures of performance and effectiveness, but typical market indicators of success (i.e., market share, profit, stock price) are not applicable. Therefore, the evaluation plan must use credible techniques, reliable data, and consistent methodologies without draining organizational resources.

1.1 PURPOSE

Research Triangle Institute (RTI) conducted this study to provide the foundation for implementing a results-based performance measurement system. RTI designed a system for NC OWR and similar state waste reduction outreach programs in EPA's Region 4 that will collect, analyze, report, and maintain the output-based performance measures needed to manage the

system, to monitor program scope and effectiveness, and to report to managers and key stakeholders on the program's success in accomplishing its objectives.[1] Key questions we have addressed in this study include the following:

- What is the current best practice for collecting and analyzing information about the effectiveness of waste reduction and pollution prevention technology deployment?
- Who are the key users of the evaluation system? What are their information needs?
- What are the key sources of information for the evaluation system? What information do they provide?
- Given the sources and uses of data, what are the key variables for the system? Which variables already exist, and which need to be defined and constructed? At what levels are they measured and over what time frames?
- What methods should be employed to convert raw data into usable information, including performance metrics?
- How will database users access the system?

This report summarizes the study and describes the database system that we developed to assist the NC OWR and other waste reduction offices in Region 4 in tracking and evaluating their efforts.

1.2 APPROACH AND PROCEDURES

The project included six tasks. During the first task, we examined existing work on pollution prevention measurement and examined how pollution prevention outreach offices keep track of and evaluate their efforts. We identified approaches that could be used in this project and discussed how they might be adapted for this particular application. The result of this task was the first working paper, which we circulated to interested people in the waste reduction offices in Region 4. Sections 2 and 3 contain a revised version of the working paper.

In Task 2, we examined the needs of the users of an information collection and evaluation system. We talked with each of the pollution prevention offices in Region 4 and learned of their information needs and ways in which they would use the information in their day-to-day operations. Using this information, we developed a preliminary design of the information the database system should provide to its users. We explained this design in Working Paper #2, which was circulated among the Region 4 offices. As we received comments on this working

[1] Region 4 states are Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.

paper, we adjusted the design. Much of what we learned about the data and reporting needs of the users of the system is contained in Section 4.

In Task 3, we examined the information sources commonly used by the Region 4 offices and also investigated other databases that could be accessed and used by this system. One of the important sources of information for evaluating the impacts of the service was the customer follow-up survey that we developed in conjunction with NC OWR. This survey, included in Appendix A, has been programmed into the database system, and its data will be used in developing metrics and reports.

In Task 4, we defined metrics that would be calculated and reported by the database system. We developed process metrics, customer satisfaction metrics, and impact metrics. These metrics were programmed into the standard reports that we developed for the database system.

In the fifth task, we constructed a database system for collecting the needed information, calculating the metrics, and performing other needed administrative functions. This database, called the Pollution Prevention Outreach Tracking and Assessment System (PPOTAS), is a Visual FoxPro application. There are two versions of the program: a stand-alone executable file, which does not require users to have Visual FoxPro on their computers and an uncompiled version, which does require Visual FoxPro. The first version does not allow users to make any changes to the structure of the database tables, forms, or standard reports; the second version can be customized in any way, since the source code is part of the uncompiled program.

While constructing the database, we did our best to consider the needs of all of the pollution prevention offices in Region 4. However, we customized some of the specific features of the system to meet the needs of the NC OWR. Some of the other offices may need to customize the program for their own use.

In Task 6, we developed a draft report summarizing the project and the database. We also wrote a users' guide for the database, which is a separate document.

1.3 ORGANIZATION OF THE REPORT

This report contains five additional sections and one appendix. Section 2 provides background on the project and the theoretical framework for developing pollution prevention outreach assessment metrics. Section 3 reviews the current practice for tracking and evaluating pollution prevention outreach and other types of technical assistance projects. Section 4

discusses the needs of the assessment system's users and ways this project addressed those needs. Section 4 also describes the data sources available to assess pollution prevention progress and ways in which the data are integrated into this system. Section 5 provides the list of metrics calculated by the PPOTAS and specifies the standard report that produces each metric. Section 6 describes the database design, including the database tables, data entry and browsing forms, and standard reports. Appendix A contains the NC OWR survey. The PPOTAS *Users' Guide* is a standalone document.

SECTION 2
BACKGROUND AND THEORETICAL FRAMEWORK

The pollution prevention offices sponsored by EPA's Region 4 provide a variety of services to businesses related to waste reduction. These offices aim to enhance the environmental and economic performance of the businesses they serve by preventing the generation of waste. In this section, we briefly describe the variety of services offered in these offices and present a theoretical framework for evaluating the success of these services.

2.1 POLLUTION PREVENTION OUTREACH SERVICES IN EPA REGION 4

Pollution prevention outreach services might include one or more of the following:

- direct technical assistance
- workshops, training
- newsletters
- referral
- information (e.g., literature search)

The NC OWR operates three different programs, each with the goal of assisting industry in reducing waste. Through their Pollution Prevention Program, NC OWR provides free, nonregulatory, technical assistance to industry covering all media including air emissions, waterborne pollutants, toxics, hazardous waste, and industrial solid waste. Much of the assistance offered through this program is provided through on-site assessments. Agents typically visit a plant and conduct an extensive waste audit. The agents follow up the audit with a report to the company recommending a number of steps to reduce its waste and emissions. Through this program, NC OWR also provides the training and guidance necessary for industries to comply with regulatory requirements. This training and assistance is accomplished through workshops, publications, and information referrals.

The other two programs NC OWR operates are somewhat outside the scope of this project, but they complement the services of the Pollution Prevention Program. The Solid Waste Reduction Program works with local governments, state agencies, businesses, and industry to encourage source reduction, recycling, reuse, and composting. This program also aims to develop a recycling infrastructure within the state and promote a waste reduction ethic through behavioral change. The NC OWR also runs the Southeast Waste Reduction Resource Center to provide technical assistance to the other eight states in EPA's Region 4 through outreach, training, education, and publications.

The other state pollution prevention offices in Region 4 vary in the type of services they provide to firms. Each state offers nonregulatory, on-site technical assistance, although this assistance may be provided either by the pollution prevention offices or through a cooperative effort with another nonregulatory institution (e.g., Center for Industrial Services at the University of Tennessee and the Waste Reduction and Technology Transfer [WRATT] Foundation in Alabama). On-site technical assistance is provided free of charge and is conducted by engineers and scientists, who often are university professors and other trained personnel. Most of these programs are only a few years old and are still experimenting with methods for promoting and evaluating their services.

The pollution prevention offices in Region 4 also offer a variety of services in addition to on-site technical assistance. For example, many provide literature search, referral, and networking services. Mississippi provides an Information Exchange that can be accessed with a modem and personal computer. This service is available to business, industry, and the general public. The Information Exchange includes a Waste Exchange where users can list waste materials they are interested in buying or selling. Users of Mississippi's Information Exchange can also perform literature searches from the library and have access to a message board where they communicate by computer. This mail system allows any user to post a question on the board and receive feedback or share information with other users.

State pollution prevention offices use two methods for targeting potential clients. Some states use secondary data to target individual firms based on certain criteria (e.g., the size of the firm, industry, or Toxics Release Inventory [TRI] emissions). Others use direct mailings, advertisements, and conferences to inform the public about their services. They may also get referrals from other clients, trade groups, or other outreach services. Methods for identifying target firms may change as more assessments are completed or as the pollution prevention efforts solicit different geographic regions of the state. However, in all cases, the final decision to seek assistance lies with the firm.

2.2 A THEORETICAL FRAMEWORK FOR EVALUATING POLLUTION PREVENTION OUTREACH

Any plan for assessing or measuring effectiveness must be based on the goals of the program and on an understanding of the processes by which those goals are met. Since people usually respond to assessment by emphasizing results that are measured, a close connection between performance measures and program goals assures that these goals are reinforced by the assessment methodology. Before examining the state-of-the-art in evaluating pollution

prevention and other types of outreach programs, we developed a framework for understanding these goals and processes.

The pollution prevention programs in EPA's Region 4 seek to reduce the environmental impact of the companies they serve. As a secondary outcome, they often improve the economic performance of these companies. Figure 2-1 represents the process by which this improved economic performance occurs. The first frame represents the policy action that authorizes and funds a pollution prevention outreach program. The second frame illustrates the provision of information to a target firm (client), either through a technical assessment, literature search, workshop, etc. The third frame shows that this information causes the firm to take some action (e.g., changing its inventory system to reduce waste due to out-of-date inventory). This action has some effect on the economic and environmental performance of the firm, as shown in Frame 4a. The new process might also improve consumer welfare because products with lower prices or higher quality are produced (Frame 4b). Finally, firm performance has an impact on the performance of a region or nation (Frame 5). The feedback loop between Frames 5 and 1 represents the possibility that information about the effectiveness of the policy will influence future public funding decisions.

2.2.1 Transfer of Technological Information and Services

The strength of the linkage between Frames 1 and 2 depends on the efficiency with which the pollution prevention program provides information and services. This input to this process is public resources, and the output is technological information and services to firms. Thus, the first set of indicators of program performance should measure the efficiency of producing these outputs.

2.2.2 Waste Reduction Technique Adoption and Innovation

Progression from Frame 2 to Frame 3 requires the company to accept the information and assistance provided and adopt these new techniques. The information provided by the pollution prevention agent will lead to a process change by the company that may fall into one of several categories:

- Manage Inventory: proper control over raw materials, intermediate products, final products, waste streams
- Modify Production Process: improved efficiency through improving operations and maintenance procedures, changing materials, modifying existing equipment, or substituting more efficient equipment

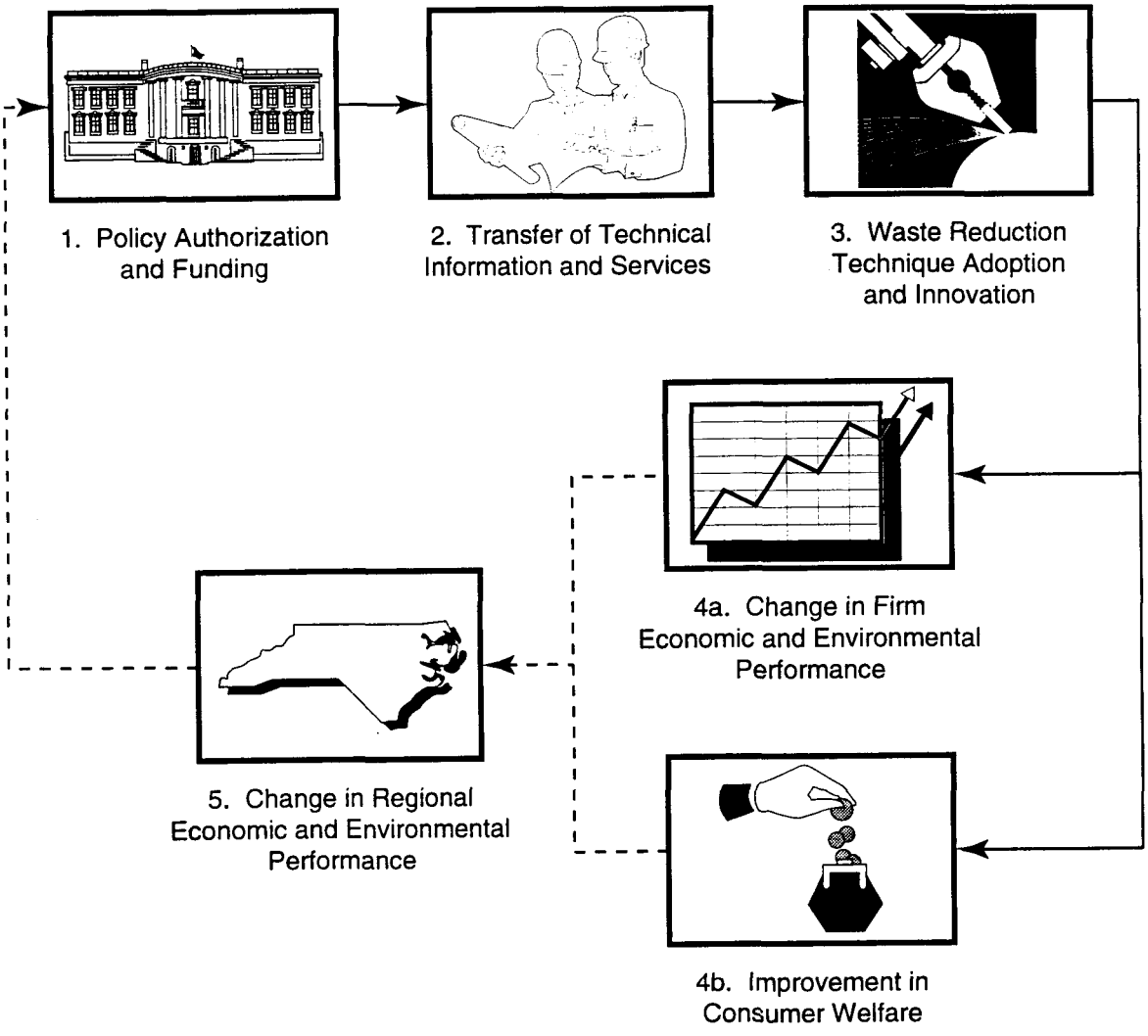

Figure 2-1. The Linkages Between Pollution Prevention Assistance and Firm and Regional Performance

- Reduce Waste Volume: segregation, concentration
- Recover Waste: on-site, off-site
- Redesign Products: lower total life-cycle environmental costs (Hunt, 1990-91)

The strength of the linkage between Frames 2 and 3 depends on several factors, including

- the quality and appropriateness of the technical information that is transferred to the client firm;
- the firm's perception of the profitability of adopting a new process or product; and
- the firm's management skill, access to information about the technology, and capacity for processing information and implementing the technology.

Thus, the second set of metrics regarding the effectiveness of pollution prevention programs should measure the extent to which the program has a positive influence on these factors and on the firm's willingness to adopt new techniques for waste reduction.

2.2.3 Change in Firm Performance and Improvement in Consumer Welfare

The strength of the linkage between Frames 3 and 4a and b depends on both technical and economic factors. Technical factors determine, in part, the extent of the reduction in cost, environmental burden, or improvement in quality induced by the new technology. Economic factors determine the distribution of the benefits of reduced cost and improved quality among producers, downstream firms, and consumers. Economic factors also determine the demand for and profitability of a new product, a higher quality product, or a product with improved environmental characteristics. Metrics of the effectiveness of applying recommendations and techniques on the environmental and economic performance of the firms should indicate the extent to which those services had a direct impact on waste generation, resource use, cost, quality, sales, or price. Increases in sales may lead to expanding employment at the firm; this change should also be measured.

2.2.4 Change in Regional Economic and Environmental Performance

The linkage between firm performance and regional or national performance depends on both microeconomic and macroeconomic factors, including

- the distribution of profits,
- the nature of labor contracts, and
- regional linkages with downstream and upstream firms.

The development of a regional input-output model is beyond the scope of this project. Furthermore, considering these regional benefits is not necessarily important when examining the effectiveness of the pollution prevention program. We limited the scope of our analysis to the effects of the services provided by the pollution prevention program on the firm.

2.3 SUMMARY

To fully assess the effectiveness and impact of pollution prevention outreach activities, we must develop three types of information:

- data regarding management and control over resource allocation and the efficiency of technical service delivery;

- assessment of the program's response to the need or demand for the service and data that determine whether companies use information and implement techniques recommended by the pollution prevention services; and

- data that measure the direct impact of these techniques on the economic and environmental performance of firms.

SECTION 3
CURRENT BEST PRACTICE FOR POLLUTION PREVENTION EVALUATION

Before developing measures of the success of pollution prevention efforts, we examined previous work in this area. The U.S. has many pollution prevention offices, most of which are publicly funded. Many of these offices have examined the evaluation issue, and several reports have summarized their evaluation efforts (National Roundtable of State Pollution Programs, 1994; Goldberg, 1993; Pacific Northwest Pollution Prevention Research Center, 1994). These reports provide some guidance on developing a set of metrics of pollution prevention success.

We examined evaluation practices in the Region 4 offices, in other pollution prevention offices, and among other types of technical outreach service providers. We described their practices, noted their weaknesses, and discussed improvements. In this section we describe an evaluation design that fits the theoretical model developed in the previous section. In describing the evaluation design we explain the current practices of the NC OWR and the other offices in EPA's Region 4. Since the purpose of this project is to provide the Region 4 offices with a useful method for tracking and evaluating their projects, we carefully considered improvements to their current practices. We briefly discuss the offices' data reporting activities and recommend improvements for data collection and management. In addition, we examine in this section the efforts of other pollution prevention offices, assess methods of evaluating other types of outreach services (e.g., industrial extension), and consider applying some of their ideas to pollution prevention outreach.

3.1 A PROGRAM EVALUATION STRATEGY

In Section 2, we concluded that a pollution prevention program evaluation must provide three types of information:

- data regarding management and control over resource allocation and the efficiency of technical service delivery;
- assessment of the program's response to the need or demand for the service and data that determine whether companies use information and implement techniques recommended by the pollution prevention services; and
- data that measure the direct impact of these techniques on the economic and environmental performance of firms.

These three types of needs have been addressed with three types of program evaluation, respectively:

- process evaluation and program monitoring, which measure the quantity and type of services provided;
- customer satisfaction and valuation, which measure the quality of the services provided, customer satisfaction with services, and changes in customer behavior; and
- impact analysis at the firm, consumer, and regional level, which measures the outcomes of the program's services.

This distinction between evaluation types is useful not only because they fill different needs, but also because they are performed at different periods in the development and execution of a program's mission. Figure 2-1 illustrates the timing of the relationship between program funding and impacts on firms and regions. Program effectiveness depends on establishing and strengthening the linkages between each action or result, as depicted in each frame. Thus, evaluation at each stage involves measuring the strength of those linkages.[1]

For example, the strength of the linkage between program funding and technology services is evaluated by the *process evaluation* metrics, which describe how well program resources are used to provide services to clients. The strength of the linkage between client service and actions taken by firms might be measured by *client satisfaction and valuation* metrics, which measure whether the services provided by the programs meet the clients' needs and whether clients' behavior changes. The strength of the linkage between actions taken by firms and firm economic and environmental performance and the linkage between firm performance and consumer welfare are gauged by *firm and consumer impact* metrics. The linkages between firm outcomes and regional economic and environmental outcomes can be described by secondary regional economic and environmental data and represent the long-run mission of most pollution prevention programs. Combining these three types of evaluations—process evaluation, customer satisfaction, and impact analysis—into a single evaluation program assures that all of the linkages are monitored and that management decisions can be based on reliable program feedback.

Table 3-1 summarizes most of the information currently collected by pollution prevention offices in Region 4 and in other regions in the country.[2] The table is separated into client information, project information, client satisfaction and valuation information, and impact

[1] Mark, Feller, and Glasmeier (1994) refer to these intermediate linkages as mediating variables. A change in a firm's knowledge is one example of an important mediating variable.

[2] For pollution prevention offices in Region 4, we contacted each by telephone and discussed their data collection and evaluation activities. Information about other state pollution prevention offices was derived from a report by the National Roundtable of State Pollution Prevention Programs (1994).

TABLE 3-1. INFORMATION COLLECTED BY POLLUTION PREVENTION PROGRAMS

Data	Collection Method	Storage and Maintenance	Use
Client Information			
Contact information	First contact/client and project tracker form	Client and project tracking system or paper files	Process metrics, management
Type of organization[a]	First contact/client and project tracker form	Client and project tracking system or paper files	Process metrics, management
Standard Industrial Classification (SIC) Code	First contact/client and project tracker form	Client and project tracking system or paper files	Process metrics, management
Number of employees	Pre-site visit information form[b]	Client and project tracking system or paper files	Process metrics, management
Number of shifts	Pre-site visit information form	Client and project tracking system or paper files	Process metrics, management
Sister facilities in N.C.	Pre-site visit information form	Client and project tracking system or paper files	Process metrics, management
Emissions[c]	WRMS,[d] TRI	WRMS, TRI	Client targeting, pre-site visit assessment
Facility and product description	Pre-site visit information form	Paper files	Client needs assessment
Processes associated with pollutant releases	Pre-site visit information form	Paper files	Client needs assessment
Environmental permits	Pre-site visit information form	Paper files	Client needs assessment
Compliance problems	Pre-site visit information form	Paper files	Client needs assessment
Waste streams of greatest concern	Pre-site visit information form	Paper files	Client needs assessment
Company waste reduction policies, plans	Pre-site visit information form	Paper files	Client needs assessment

(continued)

TABLE 3-1. INFORMATION COLLECTED BY POLLUTION PREVENTION PROGRAMS (CONTINUED)

Data	Collection Method	Storage and Maintenance	Use
Client Information (continued)			
Past assistance	First contact/client and project tracker form	Client and project tracking system or paper files	Program management, client satisfaction
Source of referral	First contact/client and project tracker form	Client and project tracking system or paper files	Process metrics, effectiveness of marketing
Project Information			
Type of waste involved	First contact/client and project tracker form	Client and project tracking system or paper files	Process metrics, management
Assistance level[a]	First contact/client and project tracker form	Client and project tracking system or paper files	Process metrics, management
Nature of request	First contact/client and project tracker form	Client and project tracking system or paper files	Process metrics, management
Nature of assistance	First contact/client and project tracker form	Client and project tracking system or paper files	Process metrics, management
Status of project	First contact/client and project tracker form	Client and project tracking system or paper files	Process metrics, management
Waste reduction opportunities identified	Site visit reports	Paper files	Process, impact metrics
Time spent on project	First contact/client and project tracker form	Client and project tracking system or paper files	Process, impact metrics

(continued)

TABLE 3-1. INFORMATION COLLECTED BY POLLUTION PREVENTION PROGRAMS (CONTINUED)

Data	Collection Method	Storage and Maintenance	Use
Client Satisfaction and Evaluation Information			
Waste reduction opportunities implemented	Follow-up survey or visit	Survey database	Customer satisfaction/valuation, intermediate impact
Reason for implementation or not	Follow-up survey or visit	Survey database	Customer satisfaction/valuation, intermediate impact
Market cost of services	Follow-up survey or visit	Survey database	Customer satisfaction/valuation, intermediate impact
Quantitative ranking of services	Follow-up survey or visit	Survey database	Customer satisfaction/valuation
Impact Information			
Client changes in environmental policies and plans	Follow-up survey or visit	Survey database	Intermediate impact
Change in compliance status	Follow-up survey or visit, secondary data	Survey database	Intermediate impact
Change in attitudes	Follow-up survey or visit	Survey database	Intermediate impact
Development of new ideas	Follow-up survey or visit	Survey database	Intermediate impact
Change in waste output, by media	Follow-up survey or visit, secondary data	Survey database, TRI, WRMS	Impact analysis
Change in cost of production	Follow-up survey or visit, secondary data	Survey database, secondary data	Impact analysis

[a]Either industry, government, university, private citizen, etc.

[b]This form is only filled out for facilities receiving site visits.

[c]These data are available for TRI reporting facilities only.

[d]The North Carolina Office of Waste Reduction uses a Waste Reduction Management System, which combines TRI data with emissions data from other sources. Other offices simply use TRI.

information. For each data item listed, it provides a summary of how the data are obtained, how they are stored and maintained, and how they can be used in an output-based performance metric system. We briefly discuss how these data are collected and analyzed for process evaluation, customer satisfaction and valuation, and impact analysis.

3.1.1 Process Evaluation and Program Monitoring

Almost all publicly funded pollution prevention and other technology outreach programs perform some type of process evaluation or program monitoring (Shapira, Youtie, and Roessner, 1994). The scope of a process evaluation is confined to assessing a particular program's accomplishments in meeting its immediate objectives and to measuring the level of effort, rather than assessing impact. These evaluations can include analysis of administrative practices, staffing patterns, caseloads, and unit costs. They provide useful data for a number of management functions, including resource allocation, identification of potential problems, personnel evaluations, and marketing analyses. Process evaluations also provide information to customer satisfaction and impact evaluations, since they examine critical first determinants of success or failure (Levitan and Wurzburg, 1979) and provide a context for interpreting the results of the impact analysis (Oldsman, 1994).

Several dimensions of process evaluation are relevant to pollution prevention programs:

- operational elements, such as decisionmaking structure, political interactions, staff competence, facilities, financial practices, and support services;
- a description of the clientele and the services provided to them—to determine whether the target population is being served;
- environmental factors that affect program operations such as legislative budgeting calendars, other environmental and technical service agencies, and public/private cooperative arrangements; and
- a determination of whether the intervention leads to an immediate objective. For example, this point might answer the question, "Are our clients aware of the newly available waste oil recovery system?".

A process evaluation that includes each of these elements can provide a complete picture of the allocation of program resources, the efficiency with which they are used, and the short-term results of program operations. In the case of pollution prevention outreach programs, operational information might include

- staffing and management information, including some type of skills inventory for the technical staff;

- the number and type of firms served or contacted (often broken down by categories that may include size, industry, location, or other variables that describe the target population);
- the types of services provided;
- the media or specific wastes addressed by each project;
- the number of hours that were devoted to each contact; and
- miscellaneous information about the service delivery, such as the number of first-time contacts, the number of repeat customers, the number of completed projects, the number of successfully completed services, and information about client payment for services, where appropriate.

Most pollution prevention offices have at least one method for collecting and maintaining information about their programs, their clients, and the impact of their programs. Most maintain a database of clients that contains basic client information. This information is usually collected over the telephone from the client when they call to request assistance. The information they commonly collect includes

- basic contact information (name, address, type of organization);
- company size (number of employees or total sales); and
- Standard Industrial Classification (SIC) code.

Many states collect additional information about clients prior to a site visit or specific project. This information usually consists of more detailed information about the emissions or releases of the company, permits they hold, processes associated with releases, any compliance problems they might be having, and the company's waste reduction policy/strategy. Sometimes secondary sources are consulted, such as the TRI and the Biennial Reporting System (BRS). North Carolina uses WRMS to retrieve information about many types of releases. This information is used to assess a company's pollution prevention priorities.

Once a project is initiated, most programs collect information specific to each project, including

- subject area of assistance (i.e., type of waste—air, solid, toxic, water, hazardous);
- type of assistance provided (e.g., presentation, on-site assistance, referral);
- pollution prevention actions recommended;
- dates of activities (e.g., first inquiry, site visit, report);
- status of project; and
- resources spent on the project (e.g., time spent, by whom).

Although this last item is quite important for developing process and impact metrics, it is tracked by very few programs. NC OWR has only begun tracking this variable in the last year or so.

All the states provide a written report outlining opportunities for pollution prevention at the site after completing an on-site technical assessment. These reports are intended for the private use of the firms and are not part of any regulatory report.

For states that conduct seminars and workshops, distribute information, or provide referrals, several process variables are commonly tracked. These include the number of attendees at workshops, the number of referrals, and the number of newsletters or publications distributed.

3.1.2 Customer Satisfaction and Valuation

After establishing the efficiency or effectiveness with which technology services are offered to clients, program evaluations must establish that the clients acted on the services that were offered. For example, if a new process has been recommended to a client, that service will have no impact unless the customer implements the suggestion. Several factors can affect the client's propensity to adopt a new waste reduction technique that has been recommended. First, clients' assessment of the quality of the information, service, or technology will affect their decision to take action. Second, clients' assessment of the likely profitability of adopting the technology will also affect their decision to adopt. Both types of information are essential. Process measures have little meaning without some assessment of quality, and information about the appropriateness of the service can address fundamental issues of resource allocation.

Customer satisfaction is multidimensional. For example, a customer may be satisfied with the competence of the service provided but may have felt that the engineer could have taken more time to explain things more carefully. Most customer satisfaction surveys include more than one component of customer satisfaction; however, none make any attempt to combine these measures into any type of satisfaction index. Furthermore, few customer satisfaction metrics are ever publicly reported.

Many pollution prevention programs conduct a formal or informal assessment of how the customer rates or values the services that were provided. Formal assessments are usually surveys sent to the companies some time after the assistance. The companies are asked to provide a rating for the service or an estimate of the service's cost if a private consultant had conducted it. Surveys often ask companies if they would use the service again, and some ask whether they would be willing to pay for the service. These follow-up surveys might also include indicators of service impact as explained in the next section.

The NC OWR and several other states employ one measure that is very useful for making the linkage between the service provided to the client and the client's change in behavior: the number (or percentage) of pollution prevention recommendations that have been implemented by the company. This variable indicates that the recommendations were appropriate and that the engineers effectively communicated the benefits of the recommendation to the client. They might also ask why or why not these recommendations were or were not implemented.

Informal assessments of customer satisfaction are accomplished by visiting companies and talking with them about the service. This type of informal assessment is subject to a great deal of bias, since customers are less likely to provide honest assessments to the engineer who provided those services, particularly if they were not happy with the service.

3.1.3 Impact Analysis

By far, impact analysis is the most difficult type of evaluation to apply to pollution prevention outreach programs. Impact analysis answers the bottomline questions directed at determining whether the program is achieving its overall mission. In the context of pollution prevention programs, impact can be measured at two levels: impact on client firms and impact on the region served by the program. The impact on client firms occurs before any impact on the region can be detected, since the regional impacts are the result of firm impacts. An analysis of client impact requires monitoring changes in firm performance and examining these changes as a function of a number of variables, including the pollution prevention information provided by the program.

A properly designed impact evaluation must recognize and acknowledge the difference between association and causation. Establishing an association between a pollution prevention program and impact requires only data on the incidence of the two phenomena and a statistically significant relationship between them. Establishing impact or causality requires demonstrating that, when controlling for other factors, the treatment group (those receiving the assistance) behaved or performed significantly differently from the control group. Demonstrating this difference generally requires comparing time-series data on waste reduction for client firms to time-series data for other similar firms.

The current practices of pollution prevention programs and other types of outreach programs fall far short of establishing causality between intervention and impact. Some states include questions about impact in their follow-up questionnaires and site visits. Since the overriding goal of these programs is to reduce the volume of waste generated by clients, the

impact questions usually focus on waste. Clients are generally asked to estimate the change in the volume of waste resulting from the assistance provided. Often, they are also asked to provide estimates of economic impact, such as increased sales, reduced costs, and loss avoidance. In addition some programs ask clients to estimate whether the intervention saved any jobs. These questions often have very low response rates, in part because clients may have difficulty calculating the estimates. The NC OWR and other programs also ask about changes in clients' compliance status, changes in attitudes toward pollution prevention, changes in clients' official pollution prevention policy, and the development of new pollution prevention ideas.

Impact analysis for many programs is much less formal than the survey methodology described above. Typically, the engineers visit a plant to determine the effectiveness of the recommended actions. Some states formulate case studies that quantify the environmental and economic benefits resulting from the pollution prevention recommendations; however, this is generally not done for each project. In most cases, case studies are only conducted for successful projects. This type of bias is clearly not acceptable in a system that seeks to fairly evaluate the impact of the program on all clients and to understand the factors influencing the success of a project.

Intermediate indicators of program impact may be important to a pollution prevention program assessment. Changes in the quantity of wastes generated by a plant assisted by the program may take several years, as pollution prevention projects are evaluated, the investment is made, new equipment is bought or products are redesigned, and the new process or product is implemented. These impacts may be captured in process—that is, to show that, although bottomline impacts have not yet occurred, preliminary indicators of impact are favorable. Some intermediate impacts might include investment in new equipment, changes in scrap or rework rates, employment of people devoted to pollution prevention, changes in attitudes about pollution prevention, and development of a pollution prevention plan or policy at the company.

3.2 DATA STORAGE AND MANAGEMENT

While all states have some portions of their data computerized, few have developed any type of standardized, comprehensive management information system for evaluation purposes. All of the programs maintain customer names and addresses in an electronic database or word processing file, but this information is often very limited. NC OWR has a FoxPro system that tracks assistance to clients, but this database does not track or report on the impact of their assistance. The Alabama Waste Reduction and Technology Transfer (WRATT) Program is currently developing a database for determining the impact of assessments; the system is still in

the development stages and has not been implemented yet. The system tracks the number of employees, hours, and cost of the assessment and reporting, number of WRATT personnel, and the annual cost savings estimated by the assessment. These savings are grouped into five categories: solid waste, hazardous waste, water, energy, and other. They also track the technique (e.g., source reduction, reuse/recycling, treatment, and disposal) by the source (e.g., land, air, or water) of the savings for each assessment, including whether the land waste is hazardous. These records can then be aggregated and sorted by several different criteria to evaluate and summarize the assessments.

3.3 DATA REPORTING ACTIVITIES

Most programs produce reports that include process, customer satisfaction, and some impact metrics. The most common type of report is a report to program funders, which presents program summary and impact statistics, such as

- number of firms served by industry, size, region;
- number of firms served by type of service;
- potential waste reductions by type; and
- potential waste reduction savings by type of waste.

Most offices also produce and publish case studies of individual projects. These case study reports usually include impact metrics, such as the amount of waste reduced, decrease in cost, and return on investment, for example.

Data reporting is very inconsistent across the programs. This lack of consistency in both data collection and reporting makes benchmarking programs against each other and comparing the progress of programs over time difficult. In Section 4, we discuss more carefully the needs of the pollution prevention offices in Region 4 and make recommendations for uniform reporting systems.

3.4 RECOMMENDATIONS FOR IMPROVING DATA COLLECTION AND MANAGEMENT

Most pollution prevention offices have some type of data collection and storage system. However, much of the data collected are not kept in an electronic database, making calculating indicators of process, customer satisfaction, and impact difficult. The variables collected are also inconsistent. We provide some recommendations for collecting and managing data for process metrics, customer satisfaction and valuation, and impact metrics.

- **Provide a clearer picture of accomplishments achieved with program resources.** Relate inputs to outputs by providing estimates of the average cost of each type of engagement (e.g., $5,000 per technical assistance; $20 per referral; $50 per workshop attendee)

- **Tie services to customer actions through customer satisfaction and valuation measures.** Try to establish the importance of the service to the change in the firm's behavior by determining, for example, the probability of taking action in the absence of the service.

- **Develop consistency in estimating program impact by**
  - — providing assistance to companies in estimating impacts,
  - — establishing a baseline before service,
  - — providing worksheets for estimating waste reduction and/or cost savings, and
  - — using secondary sources of data when possible.

- **Improve the timeliness of impact information.** Since direct results often do not occur for many years, develop and collect data for intermediate indicators of impact.

- **Improve the information available to manage pollution prevention programs.** Evaluation information should be used not only to show impact to program funders but also to provide insight regarding personnel management, effective marketing strategies, and effective information dissemination techniques.
  - — Design metrics to assist the management of the program.
  - — Use metrics to identify problem areas and successful strategies.
  - — Use metrics to improve the effectiveness of marketing and to meet market demand.

- **Improve the management of the information collected.** The information about clients, projects, and impact should be collected and stored in a common data system and should be available for electronic computation of metrics and generation of reports.

Each of these recommendations is addressed in the following sections. Section 4 addresses the reporting practices and needs of the pollution prevention offices in Region 4 and explores sources of data for developing appropriate process, customer satisfaction and valuation, and impact metrics. Section 5 proposes a set of common metrics for all pollution prevention offices in Region 4. Section 6 describes the database system we have designed for collecting and reporting these metrics.

SECTION 4
INFORMATION NEEDS AND DATA SOURCES

This section summarizes what we have learned about the information needs of pollution prevention program managers and reviews the data sources available for providing this information.

4.1 INFORMATION NEEDS

The main users of the performance measurement system will be the staff and managers of the pollution prevention offices. We spoke with representatives from each of the Region 4 offices to obtain information regarding the following topics:

- the types of reports they generate and for whom these reports are intended,
- the current system used to generate these reports, and
- the kinds of information they would like to track with such a system.

Very few offices generate reports about their program operations; however, many are in the process of developing such reports.

The NC OWR develops several reports, one of which describes the results of their client surveys. Kentucky Partners, another Region 4 office, develops marketing materials that include information about the clients they serve and the dollars saved by business and industry because of their site visits. All states develop reports to send to their clients, and most have handled requests for information about the operations and sometimes the impact of their programs.

These organizations need a consistent reporting system for information about clients, projects, program operations, markets, client satisfaction, and the impact of the Region 4 pollution prevention programs. Information about clients and projects can assist pollution prevention agents in keeping track of projects and knowing the needs of their current and potential clients. Information about overall program operation and markets can help program managers define the scope of their programs and assess whether they are meeting process and market goals. Client satisfaction and impact measures can help program managers allocate resources among delivery mechanisms and respond to questions about the programs' economic and environmental impact. We provide details regarding the kinds of information that could be useful to pollution prevention agents and program managers.

4.1.1 Information Needs of Pollution Prevention Agents

The engineers who conduct site assessments and technical assistance projects for industry need several types of information to assist them with tracking their projects and improving the

service they provide to their clients. These types of information include client information and project information.

4.1.1.1 Client Information

Client-specific information can be a great help to pollution prevention agents during all stages of customer contact. For example, suppose the agent has targeted a particular company for contact (how the management might choose that company to contact is discussed below). Before contacting that company, the agent might want to know several things about it:

- How did this company come to our attention?
- What is the company's business?
- Has anyone in the pollution prevention office ever contacted this company before?
- Has this office ever engaged in any formal or informal assistance projects with the company?
- If so, who was the contact person within the company?
- Has anyone from this company ever attended a pollution prevention seminar or workshop?
- From talking with this company in the past, what have we learned about the company's primary concerns with respect to waste reduction or pollution prevention?
- Is this company a TRI reporter? If so, what chemical(s) did it report?
- What is the size of this company (employees, sales)?
- What else should I know about this person or company that will make my call/visit more successful?

Once an agent has made contact with this company, he might want to keep track of more specific information about the company. For example, the agent might record and recall the following information for subsequent visits:

- When did I call/visit this company?
- With whom did I speak?
- What was the subject of our conversation/visit?
- What specific processes are of most concern to the company with respect to waste reduction?
- What are the company's major waste streams? Are they hazardous?
- What permits does this company maintain?
- Is this company having any compliance problems?
- Has this company instituted a recycling program?
- Does this company currently engage in pollution prevention?

4.1.1.2 Project Information

Once projects have been initiated, engineers probably need more detailed information about projects to keep them on track. The following information might be helpful:

- What type of project is it (e.g., waste reduction assessment, materials substitution study, treatment study, compliance assistance, resource recycling/recovery)?
- When does the project start and when is it scheduled for completion?
- What is the history of contact with the company on this project?
- Has a report been written?
- What is the estimated amount of savings/waste reduction for the project?
- How many hours have program engineers and support staff spent on this project?
- Was a proposal made to the company, and was it accepted?
- How much time and/or investment was made by the company to complete this project?

Once the project is complete, the agent might like to know the following about the project:

- Was the client satisfied with the assistance?
- Did the client implement recommendations provided in the report?
- What did the company invest in the project?
- What were the results of the implementation?
- If there had been a compliance problem, was it solved?
- Were the goals for the project met? Were expectations exceeded?
- Were there any unanticipated problems with completing the project?
- Was the customer happy with the services provided by the program?

4.1.1.3 Summary Information

The agent might also like to have a report that summarizes his activities over a specific period, such as a performance assessment period. For example, before his performance review, he might want to know the following:

- How many different clients did I work with?
- How many different projects did I contribute to?
- What areas of expertise have I applied in these projects?
- Did I acquire any new areas of expertise?
- What percentage of my time was spent on client service?
- Did I reach my performance goals?

4.1.2 Information Needs of Program Managers

Program managers have different information needs than field agents. They are concerned with the overall operation of the program—whether resources are being used efficiently, whether the services provided are the services that clients need, whether the program is reaching its intended target market, and whether employees are performing as expected. They also might need to develop reports for public officials such as a state legislature or the EPA.

As explained in Section 3, evaluation metrics for technical assistance programs can be separated into three general categories that fit program managers' needs: process measures, client satisfaction measures, and impact measures.

4.1.2.1 Process Measures

Process measures indicate how well resources are being used to provide services. Thus, they must measure program resources and account for the use of those resources. The inputs commonly measured for management and evaluation purposes include the following:

- total labor hours spent on outreach activities by type (e.g., maintenance of resource library; document production; workshops; on-site consultation, reports, and other assistance to industry) and
- other resources (e.g., postage, copying, printing, on-line services) devoted to client activities.

Output measures are more extensive than input measures since the assistance activities can be characterized in a number of ways. Output measures might include the following:

- number of client services by type (e.g., telephone inquiry, database search, maintenance of information, workshop, site visit, report);
- number of companies (plants) assisted during the reporting period by SIC code, size, geographical area (e.g., congressional district);
- number of new projects initiated (by issue area or type);
- number of existing projects completed (by issue area or type);
- percentage of target market contacted; and
- number and attendance of group events (e.g., seminars, workshops).

4.1.2.2 Customer Satisfaction

The program manager also might want to know whether the customers were satisfied with the services they received. Their feedback indicates the quality of service and therefore provides an added dimension to the output measures listed above.

Customer satisfaction has a number of dimensions. As reported in Section 3, one of the most important issues with respect to customer satisfaction is whether customers actually acted on information provided to them. This is the first step toward the ultimate impact of the program and an important indication of satisfaction. A company implementing the pollution prevention agents' recommendations implies that the information

- was appropriate for that particular company,
- was well communicated and understood, and
- met their needs.

Customer satisfaction measures can answer the following questions for program managers:

- Does my staff have the expertise demanded by my customers?
- Is my staff responding to the specific needs of each of the companies we visit?
- Are our reports understandable and useful?
- What would this service have cost the company if it had used a private consultant for this service?
- Is the customer likely to use our services again?
- Will they refer others to us?

The answers to these questions are important to decisions about staffing, training, and marketing. Program managers will look to reports of customer satisfaction to modify their staffing and services to meet the needs of current and potential clients.

4.1.2.3 Impact Measures

Ultimately, the program managers must be concerned with whether their services are meeting the overall objectives of the pollution prevention program. Impact measures should be tied closely with program objectives as stated in the program's authorizing legislation or other official statement of purpose. Several objectives are common to most state offices of pollution prevention or waste reduction. Most seek to reduce the environmental burden of companies; to improve the compliance status of companies; and, usually, to improve the economic viability of companies. Given these three broad objectives, program managers or other program stakeholders might be interested in the following questions:

- What was the percentage of recommended projects that were actually implemented by companies?
- What is the average and total cost savings due to our recommendations?

- Have these cost savings led to lower product or service prices? Have these price changes affected the sales or market share of the assisted companies?

- What is the average and total change in environmental burden (e.g., reduction in landfill waste, reduction in hazardous chemical disposal, reduction in air emissions or water emissions) resulting from recommended or proposed investment projects?

- What is the effect of these changes on the quality of the product or service? Has this change in quality led to any change in the product's sales or market share?

4.2 DATA SOURCES

Three categories of data are generally available to pollution prevention agents and program managers to address the issues identified in Section 4.1: administrative record data, customer survey data, and secondary data.

The PPOTAS incorporates both administrative record data and customer survey data in a single database. It also provides the capacity to draw from a number of other secondary data sources because it collects information that identifies clients in the secondary databases. A potential future improvement of the PPOTAS would be a direct linkage between it and this secondary data to enable users to develop reports from the data contained in these secondary databases. Currently, however, the PPOTAS relies exclusively on the first two types of data.

4.2.1 Administrative Record Data

Data generated from project administration can be very useful for developing process and impact metrics, but they are most frequently used for process metrics. Administrative records that are useful for process and impact assessment include

- staff time sheets or time tracking records,
- customer mailing lists and other customer information,
- customer billing invoices,
- records of client correspondence, and
- project reports.

Although this information exists in almost all pollution prevention offices, the data are often scattered among different databases and paper files and therefore are not easily used for process and impact assessment. The PPOTAS combines much of this information to form a project record that provides simple access to information that would otherwise be taken from a number of sources.

Staff time sheets or time tracking records allow the agent and the program manager to assess the allocation of staff time. This information might be useful in measuring, for example, the percentage of staff time devoted to client service, the cost of providing alternative types of assistance to a client, and the efficiency of providing different types of service (i.e., economic impact per dollar of service cost).

Staff members can track their contributions to client activities by specifying on their time sheets the amount of time spent on different types of activities. For example, if a large waste reduction project is identified that involves conducting an initial site visit and a waste audit, identifying solutions, writing a report, and conducting follow-up to the report, the project might be assigned a project number and staff could indicate on their time sheets the hours they devoted to that project. The total staff time dedicated to that project can then be summed across staff members. An alternative to tracking project time on time sheets is to record the time spent on the project on some sort of project database. As explained in Section 6, NC OWR tracks staff time in this manner; therefore, the PPOTAS tracks it this way as well.

Customer mailing lists and other customer information allow program managers to characterize the group of companies they serve. This information also provides the pollution prevention agents important background information about clients that they may visit or for whom they are preparing reports.

Mailing lists are usually inadequate for informing program managers about key characteristics of the client base, such as industry, size, and location. These characteristics are important for evaluating progress toward meeting demand in a target market, such as small businesses, common sense initiative (CSI) industries, etc. Thus, a mailing list is most useful if augmented by other information that can usually be obtained by talking with the customer or from secondary data.

Similarly, a mailing list is not helpful to agents who are preparing for site visits or preparing reports. Agents will usually want more detailed information about the clients' needs. Agents might find this information in client correspondence, billing records, or secondary data.

Customer billing records can be used to track previous interactions with client companies. For example, before calling a potential client, an agent might look into the client billing records to see if the client had ever engaged in a billable project with the pollution prevention office. However, if the office does not charge for its services (none of the offices in Region 4 charge for their services), billing records will not be available. Other records must be searched to find the relevant information, if it exists.

Client correspondence may be a great source of information about the client and a particular pollution prevention assistance or project. However, client correspondence, such as telephone calls, letters, and e-mails, are rarely organized in a fashion that would allow them to be accessed easily for calculating process and impact metrics. A database that incorporates information commonly retrieved from client correspondence will organize that information in a useful manner.

Project reports typically describe the nature of the client's problem and the advice and assistance that was provided by the pollution prevention office. These reports are very helpful for determining the impact of a project on a specific firm; however, their size limits their usefulness for analyzing data in aggregate. A database can capture some of the details of the project so that it can be analyzed in aggregate. For example, projects can by described by type (e.g., waste audit, product analysis). The database is not a substitute for the project report; instead it captures some of the categorical information in the project report so that it can be more easily analyzed.

4.2.2 Customer Survey Data

A second source of information for assessing pollution prevention offices is information obtained from customer surveys. Many types of organizations rely on customer survey data as an indicator of the impact of their contact with customers. In many cases, survey data are the only available evidence of the impact of interaction with a customer. In all cases, it is the only way to tell why a client took an action in response to assistance received from a pollution prevention technical assistance.

Customer surveys can be used to collect several different kinds of data:

- information about the actions customers took in response to the technical assistance they received,
- information about their satisfaction with the technical assistance they received, and
- information about the impact of the technical assistance they received.

Referring again to Figure 2-1, recall that the environmental and economic impact of a technical assistance project depends on the customer acting on the information they received. Thus, if a client does nothing with the information that is provided, the facility cannot benefit in any measurable way. However, if the client thought that the information was useful and accurate, he may take steps to use it in the future and is more likely to contact the pollution prevention office in the future. Thus, customer satisfaction information can provide a preliminary indicator of potential future action.

Customer surveys suffer from many limitations as a source of impact data. The reliability and correctness of impact data from these surveys depends on

- the customer's ability to determine causality; that is, his/her ability to separate the impact of the assistance on changes in economic and environmental variables from the impact of other influences;
- the customer's ability to forecast impacts that may not occur for some time;
- the customer's ability to remember the baseline (pre-treatment) levels of economic and environmental variables when estimating impacts, in the case of surveys that are taken with a sufficient time lag to observe impact; and
- the customer correctly taking into account the normalization measures needed to correctly measure impact (such as holding sales volume constant when estimating changes in pollution generation and cost).

Despite these problems, customer-provided information may be better than secondary data (such as TRI or ES—202 employment data) for impact assessment for several reasons.

First, there is a long lag between the reporting year and when secondary data become publicly available. For example, the TRI data are not available until at least 1.5 years after the end of the reporting year.

Second, secondary data may not allow us to factor out variables that the customer may know about. For example, if a customer's discharge of a hazardous material increased in the year following a pollution prevention site visit, the secondary data (i.e., from TRI) might not include information that would explain why this rise occurred, such as a one-time accident that was completely unrelated to the technical assistance provided by the pollution prevention office. However, the customer can take these incidents into account when estimating impact.

Finally, note that the source of secondary data is often the same as the source of customer follow-up data: the facility. If the credibility of information obtained from such a survey is in question, then the credibility of these secondary data is in question as well.

Survey data are sometimes difficult to collect because people simply do not want to take the time to complete the questionnaire. Response rate can be improved by conducting a survey over the telephone or in person (Dillman, 1978). However, the best way to improve response rate is to make the questionnaire brief and easy to complete.

The customer follow-up questionnaire that we designed for the PPOTAS incorporates information about customers' satisfaction with the information and services they received, their responses to that information, and environmental and economic impact. We worked with the NC

OWR in developing the survey to assure that each metric in which they were interested was included. Appendix A contains the questionnaire. It was designed to help respondents provide information even when the questions may be difficult to answer. For example, in Question 8, respondents are asked to indicate whether or not a change in an economic or environmental indicator can be attributed to the project; if they answer yes, they are asked whether the change was an increase or a decrease; then they are asked to provide an estimate of the magnitude of the change. This question allows the respondent to tell us that an impact has been experienced or is expected, even if they are unable to estimate its magnitude.

4.2.3 Secondary Data

A variety of secondary data are available for constructing process metrics and for measuring the impact of pollution prevention. Although the PPOTAS does not directly access any of these secondary data sources, it does maintain identification numbers that allow users to identify a facility in many of these databases. A brief review of the content of these databases is provided below. For more details about these databases and information about how the data sources might be used in constructing indicators, see Fagg, Weitz, and Warren (1994).

4.2.3.1 Facility Index System (FINDS)

FINDS is a computerized inventory of facilities regulated by EPA that contains facility identification data and identifies other EPA programs and databases that contain more detailed information about facilities. The *FINDS User Guide* describes FINDS as a database that facilitates the complex task of maintaining and effectively using environmental data for thousands of EPA-regulated facilities (EPA, undated). It enables users to identify facilities and coordinate identification across Agency programs and databases. EPA regulates approximately 500,000 facilities, and each of the many EPA-maintained databases may use a different name and/or identification (ID) number for the same facility. FINDS links each name and ID number used by various Agency databases to a unique FINDS ID (EPA ID) number. Additionally, FINDS identifies various EPA databases that contain environmental and enforcement data for a particular facility. FINDS is an automated system that allows users to obtain accurate and timely information for regulated facilities by providing information necessary to access environmental and enforcement data in the Agency's numerous databases.

FINDS may be an integral part of any attempt to assess pollution prevention progress using existing EPA databases. It provides information that facilitates multimedia and cross-program analysis. In short, it provides a "starting point" for gathering data from various sources and/or a "cross-checking" reference for identifying missed data.

4.2.3.2 Aerometric Information Retrieval System (AIRS)

AIRS is a computerized database used by EPA to manage airborne pollution data. AIRS is primarily operated by EPA's Office of Air Quality Planning and Standards (OAQPS). The system is also used by state and local air agencies, academic research programs, environmental advocacy groups, legislative lobbyists, and private-sector individuals. AIRS consists of four subsystems:

- Air Quality Subsystem (AQS),
- Geo/Common Subsystem (GCS),
- Area Mobile Source Subsystem (AMS), and
- AIRS Facility Subsystem (AFS).

The AIRS Facility Subsystem (AFS) contains aerometric emissions and regulatory compliance data on air pollution point sources tracked by EPA and state and local air regulatory agencies. Point source data are also used by other delegated regulatory programs and by the National Air Data Branch (NADB) for estimating total yearly emissions. AFS is the most applicable component of AIRS for assessing pollution prevention progress for specific facilities.

AIRS/AFS contains aerometric emissions and compliance data on point sources tracked by EPA and state and local environmental agencies. This information is used by the states in preparation of State Implementation Plans (SIPs) to track the compliance status of point sources and to report air emissions for pollutants regulated under the Clean Air Act.

AIRS/AFS contains data for over 100,000 point source facilities. Emissions estimates are available for a subset of these facilities, generally facilities emitting more than 100 tons per year or more of the criteria pollutants.

The data in AFS is organized into four levels:

- plant,
- stack (or vent),
- point, and
- segment.

The plant is a facility represented by its physical location and defined by property boundaries. A stack or vent is where emissions are introduced into the atmosphere. An emission point is a physical piece of equipment or process that produces pollutant emissions. The segments are components of a point process that are used in the computation process.

4.3.3.3 Permit Compliance System (PCS)

The PCS is a computerized management system for tracking permit, compliance, and enforcement status for the National Pollutant Discharge Elimination System (NPDES) under the Clean Water Act. The PCS was developed for the EPA's Office of Water Enforcement and Permits (OWEP) to provide automated storage and retrieval of information on each of the more than 65,000 active water discharge permits issued under the NPDES permit program. The NPDES program regulates facilities that discharge pollutants into the navigable waterways in the U.S. Approximately 7,100 major and 57,000 minor facilities are regulated under the NPDES. The PCS is designed to support the operational and management needs of state and regional personnel as well as the EPA's OWEP. The PCS database is controlled by a database management system (DBMS) that provides direct access to authorized individuals from data terminals throughout the country via a communications network and operates on IBM computer hardware at the National Computing Center (NCC), Research Triangle Park, North Carolina. A database of permit information is maintained and is accessible through a network of user terminals across the country.

PCS contains more than 8 million separate items of information. Information in PCS is organized by individual permit; that is, the database consists of as many individual files as there are permits being tracked by the system. The information in each permit file falls into 11 separate groups of logically related kinds of information called data types. For example, a typical permit file will contain information of the following kinds:

- basic data on the permit (e.g., permit number, dates of issue, and expiration) and the facility to which it was issued (e.g., name, location, type of facility, ownership);
- data tracking milestone events in the history of the permit (e.g., date application was received, scheduled and achieved dates for completion of compliance schedules);
- data identifying each outfall within the facility and describing monitoring requirements associated with each;
- data specifying the parameters to be measured at each outfall and the limitations associated with each; and
- data describing inspections performed at the facility (e.g., type of inspection, by whom performed, comments).

In addition to these, a permit file will typically contain many other individual items of information used to ensure the effective administration of the NPDES permit program.

4.2.3.4 TRI

Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 requires U.S. manufacturers to annually report to EPA the amount of hazardous substances

released to the environment from their facilities. The yearly TRI covers approximately 330 toxic chemicals and chemical compounds. Facilities that use more than 10,000 pounds or produce, import, or process more than 25,000 pounds of a listed chemical must provide data for the following releases:

- air emissions from fugitive or nonpoint sources;
- air emissions from stack or point sources;
- water directly discharged to a stream;
- hazardous waste destined for underground injection;
- land disposal on-site (e.g., landfills, surface impoundments);
- water discharged to a sewerage authority—publicly owned treatment works (POTWs); and
- waste transferred off-site for treatment or disposal.

TRI includes data on the types and quantities of toxic chemicals released and transferred to all environmental media by manufacturing facilities within the U.S. Additionally, the Pollution Prevention Act of 1990 requires manufacturers to report detailed information abut their recycling and waste minimization efforts.

4.2.3.5 Privately Generated Business Lists

Privately generated databases contain economic data for many companies and facilities. American Businesses Information (ABI) maintains a database of plants that contain the plant's name, address, phone number, size, volume of sales, SIC code, and credit rating score. Dun and Bradstreet also maintains a database of companies that contains more extensive information about the facility's operations and its financial status.

These data can be used to populate the PPOTAS. For example, the NC OWR could import data from ABI into the PPOTAS so that they would have some information about every plant in North Carolina. They then could target mailings and evaluate the effectiveness of these mailing campaigns. They could also assess their progress toward long-run programmatic goals.

4.3 SUMMARY

Several sources of data are available for constructing metrics that address these information needs. Administrative records can be an important source of data for process metrics, particularly if they are stored and maintained in a format that makes them easy to access and analyze. Customer survey data can be used to assess customer satisfaction and impact if the

surveys are carefully constructed and administered. Secondary data sources, especially EPA sources of environmental data, may also be useful for constructing impact metrics.

The PPOTAS draws on administrative records and customer survey data to construct simple process, customer satisfaction, and impact metrics. The reports generated by the PPOTAS (explained in Section 6) produce these metrics. These metrics and their interpretations are discussed in Section 5.

SECTION 5
METRICS AND METHODOLOGY

This section defines the performance metrics calculated by the PPOTAS and describes how pollution prevention outreach program managers as well as pollution prevention agents can use them to assess resource allocation decisions, to evaluate the program's success in creating demand for its services and in meeting that demand, and to measure the direct impact of the program on the environmental and economic performance of the assisted firms. As discussed earlier, the metrics are divided into three types: process metrics, customer satisfaction metrics, economic impact metrics and environmental impact metrics.

Although we designed these metrics to apply broadly to a number of pollution prevention outreach programs, each program may have specific needs for metrics not included here. Each office can customize the PPOTAS to calculate additional metrics and to report them by revising one of the reports described in Section 6 or by designing a custom report. Customizing the system is discussed in the *Users' Guide*.

5.1 PROCESS METRICS

Process metrics assess a particular program's accomplishments in meeting its immediate objectives and measure the level and distribution of effort. These metrics focus on the relationship between the resources used by the program and the completed activities. Process metrics provide useful data for a number of management functions, including resource allocation, identification of potential problems, personnel evaluations, and marketing analyses. Process metrics also provide information to the other two types of evaluations, since they examine critical first determinants of success or failure (Levitan and Wurzburg, 1979) and provide a context for interpreting the results of the impact analysis (Oldsman, 1994).

Take 5-1 contains the process metrics reported by the PPOTAS. These metrics are produced by four different PPOTAS reports: the client report, the activity report, the events report, and the referral report. Section 6 describes these reports. The first two metrics appear in the client report, which is intended to give program managers a description of the type of firms their program is assisting and their geographical and industrial distribution and to assess changes in the makeup of the client group. These metrics may be used to compare the target population (e.g., small business, specific industries) to the actual client base.

The metrics appearing on the Activity Report describe the type of projects that the pollution prevention office has engaged in over a specific time period; the status of these projects; and the amount of staff time and calendar time required to complete each project, by

TABLE 5-1. PROCESS METRICS

Report and Metric	Definition	Data Source (Table)	Comments
Client Report			
Number of clients; percentage by type	Sum of clients engaged in a given time period for a given category; sum for category divided by total clients	Projects table, Clients table	Can calculate by client category, SIC code, location, size, etc.
Number of new clients; percentage by type	Sum of new clients for a given category; sum for category divided by total clients	Projects table, Client table	Can calculate by client category, SIC code, etc.
Activity Report			
Number of projects; percentage by type	Sum of projects over the period for a given assistance level as a percentage of all projects	Projects table	Can sum by client category, assistance level, county, etc.
Average time (hours of agent's time) spent per project	Total minutes spent divided by number of projects	Projects table	Can calculate by assistance level type, agent, industry, etc.
Average time from initiation to completion	Calendar time elapsing from initial call to project completion	Project table	Can calculate by assistance level, agent, etc.
Number of projects started but not completed; percentage of total initiated	Number of projects that were initiated minus number of incomplete projects; sum divided by total number of projects initiated	Project table	Can calculate by assistance level, agent, etc.
Events Report			
Total number of persons reached by events; percentage by event type; average by event type	Sum of attendees or number of recipients; sum by type divided by total; sum divided by number of events	Events table	Can calculate by event type
Referral Report			
Source of client referrals	Percentage of clients citing referral source	Client table	

type. These metrics may be useful for determining what type of project is using the majority of the pollution prevention center's resources and for assessing whether some types of projects are increasing. This information may help the center plan for increasing resource demands over the coming year.

If the pollution prevention outreach center conducts seminars, workshops, etc., the manager may be interested in learning which of these types of outreach efforts are most effective in reaching the greatest number of people. The events report displays the number of each type of event that took place and the average and total number of people for each event type.

Finally, the pollution prevention program manager may be interested in tracking the source of referrals. The final metric on Table 5-1 appears on the referral report and provides a breakdown of referrals by source.

5.2 CUSTOMER SATISFACTION METRICS

Customer satisfaction is important to pollution prevention outreach programs because before customers will act on the information provided by pollution prevention outreach programs, they must believe that the information is valuable and relevant to their needs. Process metrics have little meaning without some assessment of quality, and information about the customer's satisfaction with the service can address fundamental issues of resource allocation.

Table 5-2 lists the customer satisfaction metrics. The customer satisfaction metrics calculated by the PPOTAS are simple and are tied to the customer follow-up survey (Appendix A). These metrics are reported on the customer satisfaction report. The first metric is simply the percentage of respondents reporting each satisfaction level (1 = poor, 5 = excellent) on each of five customer satisfaction dimensions: knowledge and experience, technical competence, timeliness, usefulness of recommendations, and overall satisfaction.

The next metric on Table 5-2, the market value of services, measures the money customers saved by using the pollution prevention outreach services *assuming they would have purchased services even if they had to pay market value*. Market value is not necessarily an accurate measure of the value of the services received. Since pollution prevention outreach services are subsidized and provided free or at reduced charges, we do not know whether customers would still have purchased services at the market price.

The next metric of customer satisfaction is customers' willingness to pay for the services they received. The service purchase behavior of clients of subsidized programs is not a good indicator of market value since the customers are not forced to pay a full market price. In

TABLE 5-2. CUSTOMER SATISFACTION METRICS

Report and Metric	Definition	Data Source (Table)	Comments
Customer Satisfaction Report			
Number and percentage of clients reporting each satisfaction rating	Count by rating; count divided by total number of respondents	Customer survey (Q10)	Can calculate by client category
Frequency and percentage of market value of services	Frequency of each category of value of services; total number of respondents	Customer survey (Q12)	
Total and average value of willingness to pay	Sum of willingness to pay; sum divided by total number of respondents	Customer survey (Q9)	
Number and percentage of clients willing to refer	Count of companies responding Yes to question Q11; count of Yes divided by total number of respondents	Customer survey (Q11)	Can calculate by client category
Number and percentage of clients sharing information[a]	Count of companies responding Yes to Q7; count of Yes divided by total number of respondents	Customer survey (Q7)	Can calculate by client category, size, etc.

[a]This metric also appears on the economic impact report and the environmental impact report.

circumstances in which market information is incomplete, as it is here, we can estimate values by asking clients what they would have been willing to pay for the service. We assume that in stating their answers, customers consider how the service has or will affect the profitability of their operations.

The next metric in Table 5-2, the willingness of customers to refer other companies to the pollution prevention outreach office, indicates that they believe the service can help other companies. Information adds to the total value of the services to society, since the information might influence the pollution prevention decisions of other firms. This final metric is also found on the economic impact report and the environmental impact report (discussed in Sections 5.3 and 5.4, respectively), since it indicates a potential increase in both the economic and environmental impact of pollution prevention outreach service.

5.3 ECONOMIC IMPACT

Economists measure the economic impact of changes in production and market variables, such as technology, input prices, and taxes, by summing producer's surplus and consumer's surplus. Producer's surplus is the difference between production cost and product revenues. Consumer's surplus is the difference between the price that a consumer pays for a good or service and the amount that that person would be willing to pay rather than do without the purchase.

When pollution prevention outreach leads to changes in the production technique used by a firm, it can affect both producer's and consumer's surplus. Surplus is created if the production technique reduces the cost of producing a good or improves product quality. To calculate the amount of surplus created by assistance, we must know something about

- the preferences of consumers (i.e., their demand function);
- the structure of the firm's cost curve (i.e., how costs are affected by volume);
- the structure of the industry (i.e., number of competitors and nature of competition);
- the nature and magnitude of the impact of the assistance on either cost or quality; and
- the investment made by the company to implement the recommended changes.

This information is also required to determine how the surplus that is created is distributed among producers and consumers. For example, the benefits of a decrease in the cost of production might be passed on to consumers in the form of lower prices, especially if the firm has many competitors that also decrease their production costs.

These data are difficult, if not impossible, to collect. Many of the firms served by the pollution prevention programs are very small and will be unwilling to spend the time required to provide these data. Furthermore, they may consider much of this information confidential. Pollution prevention programs with small evaluation budgets do not have the resources to collect these data and construct such elaborate benefit models for each client, although this approach may be appropriate for a case study.

In the absence of the information required to estimate consumer's and producer's surplus, we can estimate components of these measures and use them as impact metrics, provided we are careful about their interpretation. For example, as explained above, we cannot assume that a decrease in cost is a measure of benefit to the firm. Similarly, we must be careful about our interpretation of the impact of increases in sales, since revenue is only one component of producer's surplus.

We must be especially careful about interpreting these metrics in a benefit-cost context. Unless we construct a careful welfare model that incorporates the benefits of the program to both firms and consumers, and the costs of the program to both firms and the government, we cannot aggregate the benefits numbers and provide benefit-cost ratio estimates.[1]

Table 5-3 contains the economic impact metrics calculated by the PPOTAS. These metrics are tied to the customer follow-up survey; thus, these metrics can only be calculated after clients have completed the follow-up survey, and the answers have been entered into the database.

The first three metrics are qualitative, intermediate indicators of potential economic impact. As explained earlier, before assistance can have any economic impact, clients must implement pollution prevention recommendations. Thus, the greater the number and percentage of recommendations that have been implemented, the greater the economic impact. These indicators are particularly helpful when the recommendations were recently implemented and the client is unable to estimate economic benefit.

The fourth metric, change in capital spending, must be very carefully interpreted. An increase in capital spending by the client does not indicate the return to that investment. Like the previous three indicators, it shows that the company invested in implementing the pollution prevention recommendations. Decreases in capital spending might also be reported. For example, suppose a client was considering a water treatment system to maintain compliance with

[1] Shapira and Youtie (1995) have made some progress toward constructing an appropriate model for comparing benefits to costs for technical assistance programs. However, this approach is still very difficult to implement.

TABLE 5-3. ECONOMIC IMPACT METRICS

Report and Metric	Definition	Data Source (Table)	Comments
Economic Impact Report			
Number and percentage of clients implementing any recommendations	Sum of clients responding Yes to Q1 divided by total responding	Customer survey (Q1)	Only for companies receiving site visits
Total number of opportunities implemented	Sum of Y's in Q1	Customer survey (Q1)	Only for companies receiving site visits
Average number of opportunities implemented per client assisted	Sum of Y's divided by Total responding to any part of Q1	Customer survey (Q1)	Only for companies receiving site visits
Number and percentage of clients increasing (decreasing) capital spending for pollution prevention	Sum of clients answering "increase" (decrease) to Q8a+ number answering yes to Q3 (no double counting)	Customer survey (Q3, Q8a)	For all plants returning survey
Number and percentage of clients reporting a decrease (increase) in annual production costs (assuming output constant) from P2 activities	Sum of clients answering "decrease" (increase) Yes to Q8b divided by Total number of clients responding	Customer survey (Q8b)	
Total and average cost change per client	Sum of cost changes reported in Q8b divided by total number of respondents providing estimates	Customer survey (Q8b)	
Number and percentage of clients reporting a decrease (increase) in regulatory fees or penalties	Number of clients reporting "decrease" (decrease) in Q8c divided by total number of respondents	Customer survey (Q8c)	
Total change in regulatory fees and average change per client	Sum of responses to Q8c dollar estimates; sum divided by number of respondents	Customer survey (Q8c)	
Number and percentage of clients reporting decrease (increase) in cost of waste handling, abatement, or disposal	Number of clients reporting "decrease" (increase) to Q8d divided by total number responding	Customer survey (Q8d)	

(continued)

TABLE 5-3. ECONOMIC IMPACT METRICS (CONTINUED)

Report and Metric	Definition	Data Source (Table)	Comments
Economic Impact Report (continued)			
Total change in waste-related costs and average change	Sum of responses to Q8d dollar estimates; sum divided by number of respondents	Customer survey (Q8d)	
Number and percentage of clients reporting an increase (decrease) in revenue	Count of companies answering yes to 8e divided by total number of respondents	Customer survey (Q8e)	
Total revenue change; average revenue change	Sum of Q8e ($); sum divided by number of respondents providing estimate	Customer survey (Q8e)	
Number and percentage of clients reporting an improvement (decline) in product quality	Total clients answering yes to Q8f; total responding yes divided by total responding	Customer survey Q8f)	
Number of clients reporting a decrease in price of the product	Total answering "decrease" to Q8f; total reporting decrease divided by total responding	Customer survey (8f)	
Number and percentage of clients sharing information	Total responding yes to Q7 divided by total responding	Customer survey (Q7)	
Total number of organizations receiving information	Sum of responses to Q7b	Customer survey (Q7)	

discharge limits as his operation grows. A pollution prevention engineer might suggest instead that the client switch from the chemical that requires water treatment to an alternative material that presents no environmental compliance issue. If the company accepts this suggestion, they avoid the cost of the water treatment. However, if the new material is more expensive than the old material, or if other costs are associated with implementing the material substitution, these costs must be considered when reporting and interpreting the capital cost savings.

The fifth and sixth metrics quantify changes in the cost of production, *holding output constant*. First, the PPOTAS calculates the percentage of clients (from among those responding to the question) that report decreases (or increases) in the cost of production as a result of the pollution prevention assistance they received. While many clients may not be able to estimate the dollar impact of the assistance on changes in production cost, they may be able to indicate that a positive or a negative change occurred. Some clients might also be able to estimate a dollar value. The sum of these dollar values (increases added to the total, decreases subtracted) is divided by the total number of clients reporting a dollar value to show the average change in costs among firms that were able to estimate impacts. This metric must be interpreted very carefully; it would be incorrect to say that all of the clients of the pollution prevention office experienced decreases in costs equal to the average. An example of how these metrics might be reported is "20 percent of clients receiving waste audits reported that their production costs declined as a result of this assistance, while 5 percent reported increases in production costs. Among those that could provide an estimate of the change, the average change was a net decrease in cost of $10,000."

The next four metrics are similar to the production cost metrics, because they provide information about the number and percentage of clients for which assistance led to a change in regulatory fees or penalties or the costs of waste handling, abatement, or disposal. Like the production cost metrics, the averages are calculated from among those clients that were able to provide an estimate and should be interpreted carefully.

The next two metrics report changes in revenue among clients. Note that changes in revenue should not be interpreted as a benefit. The real benefit to the firm from an increase in revenue is the profit margin from that increase in sales. However, since profit margins are confidential information, we simply collect and report revenue changes and interpret them appropriately.

Changes in the quality of the product can result in a change in the market price of the product. The next two metrics provide an estimate of the number of clients reporting changes in quality and any resulting changes in price.

The final two economic impact metrics measure the potential for the assistance of the pollution prevention program to have a secondary impact. The number of clients that share pollution prevention information with other firms and the number of firms with which they share it show the potential for these secondary impacts.

5.4 ENVIRONMENTAL IMPACT

Measuring the environmental impact of a pollution prevention program is at least as difficult as measuring economic impact. Constructing a measure of the environmental impact of pollution prevention requires considering several important methodological issues (Fagg, Weitz, and Warren, 1994). First, the measurement of impact implies that some baseline from which the impact can be measured can be established. Second, any change in environmental impact must be measured relative to a given production level or adjusted for changes in production. Finally, the relative risk (toxicity, acidity, reactivity, ignitability) of different pollutants should be considered if an overall measure in the change in environmental burden is desired.

Our measures of environmental impact include separate estimates of changes in discharges to air, and water, nonhazardous solid waste, hazardous wastes, and use of hazardous chemicals. We do not aggregate these measures to provide a risk-weighted index because of the complexity and data requirements of such a task. However, we do control for changes in output by asking the respondent to estimate changes based on a constant level of production.

The environmental impact metrics calculated by the PPOTAS are listed in Table 5-4. They include both qualitative measures and quantitative measures. The first two metrics indicate a change in the attitude of the client toward pollution prevention and his willingness to apply the principles of pollution prevention in his operation. Even if a client cannot report any changes in emissions or resource use, a change in his attitude about pollution prevention provides some potential for environmental impact in the future.

The next set of metrics measures the impact of pollution prevention assistance on compliance problems. Solving compliance problems may be associated with an increase in economic cost (i.e., the plant may have to spend money on new equipment to come into compliance).

The PPOTAS also calculates the number and percentage of plants that have experienced changes in the following quantities (volume of production is held constant):

- hazardous waste
- nonhazardous solid waste

TABLE 5-4. ENVIRONMENTAL IMPACT METRICS

Report and Metric	Definition	Data Source (Table)
Environmental Impact Report		
Number and percentage of clients changing environmental management practices	Total number of clients answering differently to any part of Q4 before versus after assistance; total divided by number responding to Q4	Customer survey (Q4)
Number and percentage of clients reporting new pollution prevention ideas as a result of assistance	Total number of clients answering yes to Q5; total divided by number of respondents	Customer survey (Q5)
Number and percentage of clients reporting resolution or mitigation of a compliance problem	Number of clients answering "resolved" or "reduced" to Q6; total divided by total number responding	Customer survey (Q6)
Number and percentage of clients reporting a decrease (increase) in : Hazardous waste Nonhazardous solid waste Air emissions Water emissions Use of hazardous materials	Number of clients responding "decrease" (increase) to corresponding Q8g through Q8k, reported separately; total divided by total number responding to each corresponding question	Customer survey (Q8g through Q8k)
Total change and average change per clients: Hazardous waste Nonhazardous solid waste Air emissions Water emissions Use of hazardous materials	Sum of changes reported by type; sum by type divided by number of responses for each corresponding question	Customer survey (Q8g through Q8k)

(continued)

TABLE 5-4. ENVIRONMENTAL IMPACT METRICS (CONTINUED)

Report and Metric	Definition	Data Source (Table)
Environmental Impact Report (continued)		
Number and percentage of clients reporting a change in: – water use – energy consumption	Count of clients responding "decrease" (increase) in Q8l or Qm, respectively; count divided by total number of respondents for each corresponding question	Customer Survey (Q8l through Q8m)
Number and percentage of clients sharing information	Count of clients responding Yes to Q7; count divided by total number responding	Customer Survey (Q7)
Total number of organizations receiving information secondhand	Sum of responses to Q7b	Customer Survey (Q7)

[a]This metric will not be available on Release 1.0 because the publications table will not be developed.
[b]This metric also appears on the economic impact report, and the environmental impact report.

- air emissions
- water emissions
- use of hazardous materials

For clients that report a change, the PPOTAS calculates the total and average amount of the change. These changes could be either increases or decreases. The PPOTAS does not aggregate these numbers in any way, since the comparisons would be invalid; rather, it reports them separately.

The PPOTAS also calculates the impact of pollution prevention assistance on water and electricity use. First, the database calculates the number and percentage of clients reporting a change in the use of these resources. Second, it calculates the total and average values reported.

These numbers should be interpreted similar to changes in production cost. The metric may be reported as "15 percent of the clients of the NC OWR reported a decrease in the use of water. Among those clients providing estimates, the average decrease in water used was equal to $500 gallons per year, assuming no change in production volume."

The final two environmental impact metrics are the same as the final two economic impact metrics. The sharing of pollution prevention information with other plants shows the potential for this information to have additional environmental impact in other plants.

SECTION 6
DATABASE SYSTEM

This section describes the software that allows users to collect, calculate, analyze, and report the process, customer satisfaction, and economic and environmental impact metrics described in Section 5. We provide an overview of the components and capabilities of the PPOTAS and describe Visual FoxPro, the software platform on which the PPOTAS is designed, and describes our reasons for choosing that software. This section also provides a description of each of the components of the PPOTAS, including database tables, data entry and browsing forms, database reports, and database queries. Finally, we describe improvements to the PPOTAS to increase its usefulness to pollution prevention offices. The PPOTAS *Users' Guide* provides detailed instructions for using the system.

6.1 PPOTAS COMPONENTS AND CAPABILITIES

The PPOTAS provides a system for pollution prevention agents and program managers to track information about their clients, the work performed for their clients, the special events and mass mailings they conduct, and the impact of their assistance on their clients. We designed the PPOTAS as a convenient tool to be used on a daily basis by anyone who interacts with clients.

The usefulness of the PPOTAS depends on the consistency with which information is entered. Therefore, the pollution prevention managers and agents must be committed to using the system to manage the program, to improve their service to clients, to consistently follow-up on projects, and to demonstrate the program's impact to program sponsors and potential clients. Rather than making notes about a client and their needs on a paper form or log book, agents and managers can enter this information into the PPOTAS, where it can be effectively stored and used.

Because we initially worked with the NC OWR on designing the PPOTAS, it reflects the preferences of NC OWR agents and managers with respect to functionality and database variables. Thus NC OWR employees will be able to quickly learn the system and get accustomed to using it. However, other pollution prevention offices may need to customize the PPOTAS to their own operations and preferences.

Most offices that use this first release of the PPOTAS will probably augment it with several other data sources. Project reports, which are typically long documents, are not stored within the PPOTAS and agents and managers will still use them to refer to details about waste assessments and other long-term projects. However, the PPOTAS provides a project numbering

system that will allow these reports to be filed so that they can be retrieved easily and associated with the PPOTAS client and project records. Similarly, many pollution prevention offices will still look to secondary data sources for environmental information about their clients. By storing and tracking the relevant EPA ID numbers, the PPOTAS provides pollution prevention offices a reference for these databases.

6.2 DATABASE SYSTEMS FOR PROJECT TRACKING AND PROGRAM EVALUATION

Several features are important to the usefulness of the database management system. The ideal system would have the following features:

1. **Easy to use and update.** Each time a contact is made, a project is proposed or initiated, an event is planned or held, a new person is hired, and so on, the database must be updated. It should include easy-to-use data entry forms for standard types of updates. Ideally, multiple tables would be updated simultaneously and consistently, with default values filled in automatically. In addition, pick lists for some fields would minimize keying effort and errors and maximize consistency.

2. **Easy to customize.** Since each of the pollution prevention offices using this system will have specific needs for data entry, maintenance, and reports, our system must allow nonprogrammers to design data entry forms and reports. Database management systems with a feature called "visual design" allow nonprogrammers to design data entry forms and reports.

3. **Inexpensive to develop and maintain.** Most pollution prevention offices have small staffs and budgets and cannot afford a system that requires expensive software or equipment or continuous attention. Ideally, the database application would run on software that most of the offices already have or can use for multiple functions.

4. **Easy to produce high-quality reports.** The database system should produce readable reports with minimal effort.

Several of the newer, Windows-based database systems contain all of these features. However, they are different in some ways with respect to cost and features. In this section, we review users' database needs and the features and costs of several appropriate database systems, and we recommend a database system and explain why we chose Visual FoxPro for Windows as the software on which to build the PPOTAS. We also describe several database applications that we considered before deciding to design a new system and explain why they did not meet our needs.

6.2.1 Requirements and Desirable Features of the Database System

An appropriate database application for pollution prevention offices would be based on a relational database system. Relational database systems allow users to store data in several

distinct tables, as users would naturally organize data, rather than keeping data in a single large table. By using several smaller tables, the size of the database can be reduced because redundancies are eliminated. For example, general client information is stored only once per company, not once for every project. This system also improves the quality of the data by reducing the chances for inconsistencies, and it makes updating the database quick and easy. A relational database system refers to records from several tables at once when creating reports, queries, and data entry forms.

The ideal database system for our application would require only one copy of the database for all of its users. This feature saves computer space and ensures database consistency. The database should be stored on a single computer, possibly a computer whose primary or sole function is for maintaining this database. If this computer is on a network to which the database users are connected, then the database can be accessed directly by these networked users. Users might otherwise access the database via dial-in lines through modems.

There are two different approaches to implementing a database on a network. The first approach, which we call an "ordinary" database system, more or less ignores the fact that the database is located on a network (remote) drive. The other approach is a client/server architecture, in which the database server resides on the database machine, and the database clients access the server from the networked computers. The database server is sometimes referred to as the database back end, while a database client may be referred to as a database front end.

Even an "ordinary" database system can facilitate access to the database by more than one user at a time. Most of these database systems provide a freely distributable run-time module that allows users to run database applications, such as data entry forms and standard report generators, without using the database development system. Some "ordinary" systems generate stand-alone executables that need no run-time module. Whether this system requires a run-time module or not, any number of users can access the database simultaneously, although only one user at a time can use a particular record in a particular table. Others who try to access that same record are forced to wait a short time. Furthermore, some "ordinary" database systems provide only file locking but not record locking capabilities. Lack of this feature may cause performance problems when database files are shared on a network.

The client/server database approach offers several advantages over an "ordinary" database approach. The primary advantage is that the amount of data transmitted across the network is minimized, so performance is improved. Of course, this advantage is not relevant if

the only users of the database are a small number of staff who directly access the database computer. The database servers used for client/server databases are generally larger and more sophisticated than "ordinary" database systems. Thus, they usually give somewhat better performance and provide better administration tools than "ordinary" database systems, even when used on a single, nonnetworked computer. In addition, they may offer even better import and export capabilities for accessing data in other databases, especially minicomputer or mainframe computer databases.[1]

The primary disadvantage of using a client/server approach is the increased cost. Database servers require more expensive platforms (the computer hardware plus the network operating system) than "ordinary" database systems, database server software is more expensive than "ordinary" database software, and user companies must pay for database client licenses as well.

It is possible to develop a database system using the "ordinary" database approach that can be scaled up easily to use a database server when and if that option becomes desirable. To achieve this flexibility, we need to select a database development system that is Open DataBase Connectivity (ODBC) compliant and/or supports Structured Query Language (SQL). In addition, the selected database system should also allow users to easily export database tables into the new database server system. Some of the "ordinary" database systems can be used as clients of the database server so that the data entry forms and standard reports could still be used (without reprogramming) after scaling up to a database server.

Because of the increased cost of implementing and maintaining a database server and because we feel this application will not tax the performance of an "ordinary" database system, we recommend developing an "ordinary" database system that can be easily scaled up later if desired.

6.2.2 Existing Database Applications

Before choosing a database development system and beginning to develop a program specifically designed for the pollution prevention offices in Region 4, we considered whether any database applications already exist that suit our needs. The candidates included applications already developed by the pollution prevention offices in Region 4 and database systems used by other types of technical services offices, such as manufacturing extension programs.

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[1] Nearly all database servers support a standard database query and updating language called Structured Query Language (SQL), which is also widely supported by minicomputer and mainframe computer database systems.

One drawback to buying an existing database system is that we may not be able to customize it in the future as requirements change. For this reason, purchasing the source code is desirable, if possible. We needed to consider any limitations on how we can modify and re-distribute the programs.

The first place we looked for an application that could be adapted to our needs was the other pollution prevention offices in Region 4. Kentucky Partners keeps a general business profile including the name, address, phone number, and the time of completion for any assessments they conduct. This information is stored electronically using spreadsheet software but does not offer the flexibility of a relational database or the detail required for this application. Alabama is in the process of developing a database system on a WANG computer system. The database requires users to supply information about cost savings, waste reduction, the number of personnel providing assistance, and the total cost of the assessment and report. This information can then be summarized for analysis by using one of the predefined menu choices or by creating a user-defined query. This system, however, is not compatible with Apple or IBM-compatible personal computers found in most other offices.

Other types of technical assistance programs are another possible source of appropriate database applications. The National Institute of Standards and Technology (NIST) administers a program called the Manufacturing Extension Partnership (MEP). Local MEP offices provide a variety of technical services to small- and medium-sized manufacturers, and many of their activities are similar to those provided by the pollution prevention programs. NIST requires MEPs to report on activities related to technology transfer and performance evaluation. Thus, several MEP offices have developed systems that may meet the needs of our application.

Two such systems are ProTrac, developed by Georgia Institute of Technology Research Institute, and the Manufacturer Information Database (MID), developed by Great Lakes Manufacturing Technology Center. ProTrac is an "ordinary" database system developed using FoxPro. It maintains database tables on activities, projects, results, contacts, time reporting, and customers. It provides reports on activities, open projects, closed projects, and various NIST required reports. Adapting ProTrac to our needs would require obtaining the source code for ProTrac and customizing the reports and tables. This process would probably not save much time or money over and above what would have been spent to develop a custom system.

The MID is a relational database client/server application. The database computer must be either a Sun Workstation or a PC running the Windows NT Server network operating system. Because neither Sun Workstations nor Windows NT are commonly found in the pollution

prevention offices, purchasing the software and/or hardware needed to run this program would be quite expensive for each office. Furthermore, the application costs $3,000 per license, and the INGRES Licensing Fee must also be purchased at a cost of $300 per concurrent user. If we wanted to modify this program to produce the appropriate reports, we would also have to purchase the source code. The expense of this option eliminated it from consideration.

After considering these options, we recommended moving ahead with developing a custom database application for the NC OWR and the pollution prevention offices in EPA's Region 4.

6.2.3 Selecting a Database Development System

As discussed earlier, the database development system should be an "ordinary," relational database system that is ODBC compliant and/or supports SQL. In addition, it should offer query by example or query by form, provide easy "visual design" of forms and reports, and export tables in some "standard" format that makes scaling up to a database server easy. Cost is also an important consideration.

We wanted to use existing hardware as much as possible to reduce costs. Because many excellent database development systems run on PCs under Windows (or Windows for Workgroups), which is the platform used by NC OWR, we restricted our attention to such systems. (The Windows database systems generally offer better user interfaces and more features than the DOS versions, so a Windows database was preferable for these reasons as well.)

We compared database systems with the following list of features:

- platform: PC running Windows
- data model: relational
- architecture: "ordinary" (not client/server)
- ODBC compliant
- supports SQL
- supports query by example or query by form
- allows "visual design" of forms and reports

Table 6-1 compares the leading database development systems that meet these requirements. Other popular PC database systems, including Filemaker Pro for Windows and Approach for Windows, are not listed in Table 6-1 because they are missing one or more of the required features. Any of these three database systems could be used to develop an excellent database system for the pollution prevention offices.

TABLE 6-1. COMPARISON OF LEADING RELATIONAL "ORDINARY" WINDOWS DATABASES

	Microsoft Access for Windows	Paradox for Windows	Microsoft FoxPro for Windows	Microsoft Visual FoxPro for Windows
Version	2.0	4.5	2.6	1.0
List price	$495	$495	$695	$495
Data integrity features	Excellent	Very Good	Fair	Excellent
File formats supported[a]	A, B, D, P, F, X	D, P	F, D	A, B, D, P, F, X
Visual design features	Excellent	Excellent	Very Good	Good
ODBC compliant	Yes	No[b]	Yes	Yes
SQL support	Yes	Yes	Limited	Yes
Record locking	No	Yes	Yes	Yes
Run-time module	Yes[c]	Yes	Yes	No
Stand-alone EXEs	No	No	Yes	Yes

[a]A = Access, B=Btrieve, D=dBase, F=FoxPro, P=Paradox, X=Excell, and several other spreadsheet programs.

[b]Version 5.0 is ODBC compliant.

[c]For $495, a distribution kit for Microsoft Access can be purchased. It allows royalty-free distribution of the run-time module.

Source: Riciardi, Sal. 1994. "Developer Databases: Serious Solutions." *PC Magazine* 13(15):177-226. September 13.

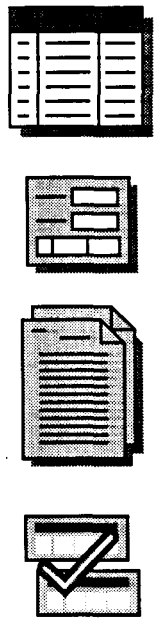
We polled the pollution prevention offices in Region 4 to learn their preferences regarding a database platform. There were an equal number of votes for Microsoft Access for Windows and Microsoft FoxPro for Windows. We decided to use Microsoft FoxPro for Windows, since the NC OWR was already using Microsoft FoxPro for Windows for their existing tracking system.

Before designing the database, we waited for the release of the new version of Microsoft FoxPro. Developing a database in a software program that would be obsolete once the new version was released seemed unwise. The new version, called Microsoft Visual FoxPro, improves on the visual design features of the Microsoft FoxPro for Windows version 2.6. This system was reported to perform better than Microsoft Access because of a faster, more efficient engine. Furthermore, it provides royalty-free executables, which allows us to distribute the PPOTAS to the pollution prevention offices in Region 4 without the offices having to purchase the program, unless they want to customize the PPOTAS.

Microsoft had promised the release of Visual FoxPro in May 1995; unfortunately, they did not release the product until August. This delay in release is, in part, the reason for the delay in the release of the PPOTAS. The cost of the professional edition, which is required for database development is $495.00.

6.3 PPOTAS COMPONENTS

Figure 6-1 provides an overview of the PPOTAS design. The database contains several elements: tables, forms, reports, and queries. Tables, containing rows and columns, are the heart of the database because they contain the data. Each row contains a single record; each column contains one field or category of data for the record.



Tables are the heart of the database: they contain data.

Forms display data on the screen for browsing and editing.

Reports display data in a format designed for printing.

Queries retrieve and manipulate selected data and display the results in a table format.

Figure 6-1. Components of the PPOTAS

Source: Adapted from Borland International, Inc. 1994. *Borland® Paradox® for Windows: User's Guide.* Scotts Valley, CA: Borland International, Inc. Page 36.

The tables are linked to each other by defining a relationship between a field of one table and a field of another table. These relationships can be either "one-to-one" relationships, in which at most one record in a table is related to a record in another table; "one-to-many" relationships, in which each record in a table is related to many records in another table; or "many-to-many" relationships in which each record in a table can be associated with many records in the other table, and vice versa. Section 6.3.1 describes the tables in the PPOTAS and the relationships among them.

Forms display data for browsing or editing one observation at a time. Sometimes working with data from tables one record at a time is more convenient than working with an entire table full of data. Forms allow users to customize the data fields to be browsed and can even display variables from more than one table. We use forms in the PPOTAS for browsing and adding data to the database. Section 6.3.2 describes each of the forms.

While forms are formatted to display data on a computer monitor, reports display data in a format designed for printing. Reports allow users to draw from data in any of the tables, sort and group records, calculate fields and totals, and arrange the data in some specific format. We have designed seven standard reports for the PPOTAS. PPOTAS users can also design custom reports to meet their specific analysis needs.

Queries retrieve selected data from the tables in the database and display the data in a table format. Queries can be used to answer specific questions about the data in any of the tables. For example, we may want to know which of the NC OWR clients have requested assistance about marketing secondary products. To answer this question, users fill in a query. The database uses the query to answer the users' questions and displays the answer. The query can be successively edited so that users arrive at exactly the data they were seeking.

6.3.1 Data Tables

The PPOTAS contains nine data tables, as shown in Figure 6-2:

- client table
- project table
- contact table
- survey table
- pick lists
- SIC codes
- data dictionary
- staff table
- events table

Figure 6-2 describes generally the content of each table and the relationship between each table. The PPOTAS *Users' Guide* contains a detailed data dictionary.

The tables are linked by common identifying information. For example, the client table, which contains information identifying and describing the client, is linked to the project table, the contact table, and the survey table. All of these tables contain the variable "client ID." This allows us to relate several specific projects to each client and several contacts to each client.

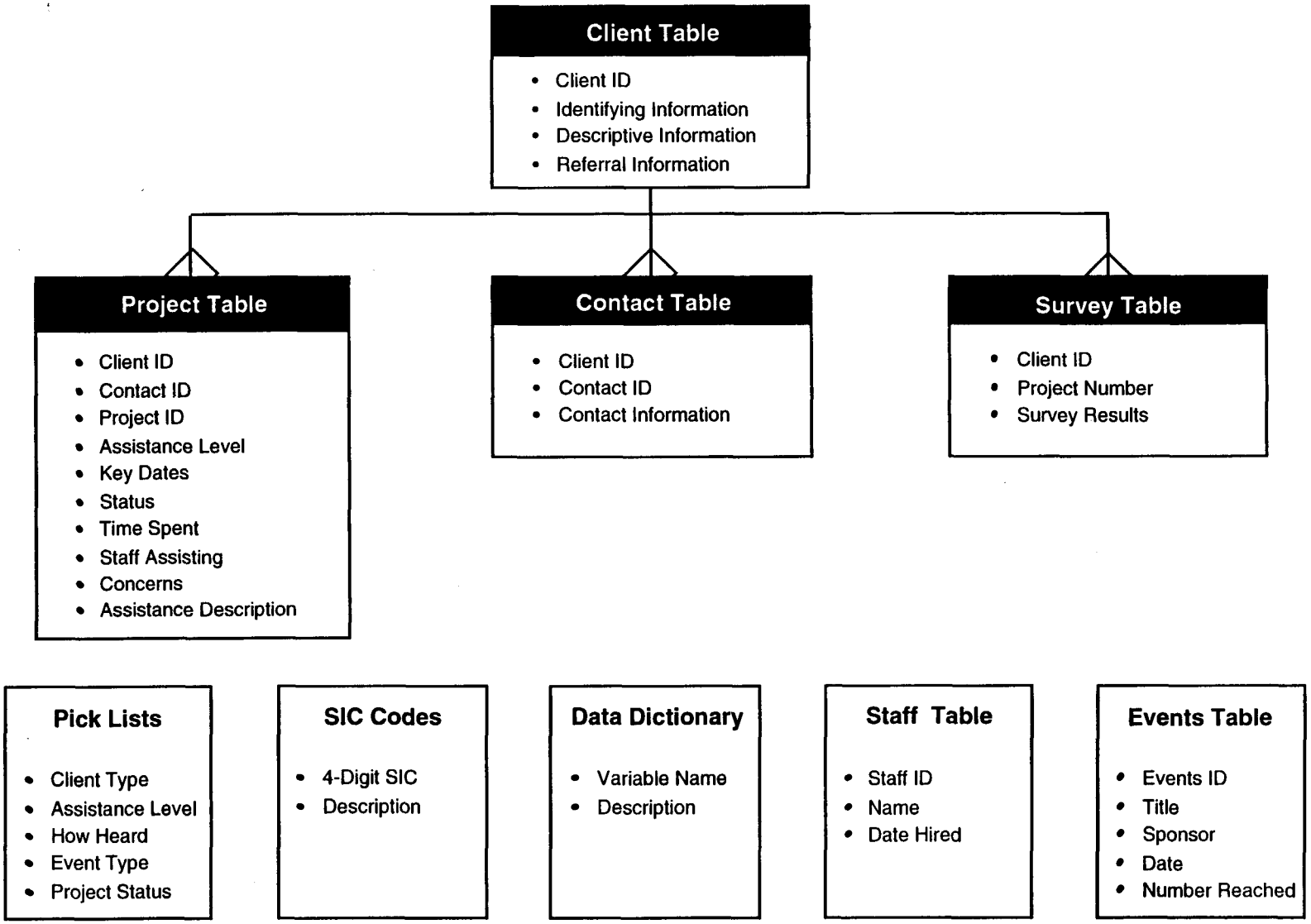


Figure 6-2. Database Tables in the PPOTAS

The project table contains information about individual projects, which we define as requests for assistance.[2] Project details are linked to the client table through the client ID. For example, the ABC Painting Company may have requested information on water-based coatings in 1995. This interaction would appear as a project in the project table, and ABC Painting Company would appear in the client table. In 1996, ABC Painting Company might request an on-site waste assessment. The waste assessment would be added to the project table, but the existing information about ABC Painting Company would not be reentered. Instead, the project record would be associated with the existing client record via the client ID. The client record can be updated if necessary.

Similarly, the contact table stores information about people at client companies that have served as contacts for projects. Within a single client company, a pollution prevention agent may work with a plant manager, the company president, or the environmental and safety officer on different projects with the same client. All of this information is stored in a table that is separate from the client table but is linked to the client table via the client ID.

The survey table is also linked to the client table. It contains the results from customer follow-up surveys that clients have returned.

The events table is not linked to other tables on the database; it provides information about workshops, training events, and mass mailings.

The database includes several supporting tables. The pick lists table contains all of the choices for categorical variables for which the user is presented a list of predefined choices. The SIC code table is also a pick list; we placed it in a separate table because it is so large. The data dictionary provides documentation for each of the variables on the database and the pick list choices.

6.3.2 Data Entry and Browsing Forms

The PPOTAS contains four data entry and browsing forms: a tracker form, which displays data from the client table, the projects table, and the contact table; the survey form, which displays data from the survey table; the events form, which displays data from the events table; and a datadict, a data entry and browsing form for the data dictionary table.[3]

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[2]The *Users' Guide* contains a glossary of terms.

[3]The database also contains report specification forms, which are used to run reports. These are explained in Section 6.3.3.

The only tables that cannot be accessed through forms are the staff table, the pick lists table, and the SIC code table. We expect that the staff table, which is very simple, will be altered relatively infrequently. Thus, we suggest that the table be altered by opening the table itself and making the appropriate changes.

Similarly, the pick lists tables can by changed by opening the tables and making the appropriate changes. Pollution prevention offices may use this table to customize pick lists to fit their own definitions of client types, assistance levels, status, etc.

For more details regarding the use of each of these forms, see the *Users' Guide*.

6.3.2.1 Tracker Form

Figures 6-3, 6-4, and 6-5 illustrate the tracker form. Information from three tables—the client table, the project table, and the contact table—appears on this form. The form is set up in three pages that can be reached by clicking on the tabs at the top of the page. The first page contains project-specific information as shown in Figure 6-3, the second page contains client-specific information as shown in Figure 6-4, and the final page contains contact-specific information as shown in Figure 6-5.

The form's design minimizes the amount of data that must be entered for new projects. For example, suppose a client calls the pollution prevention office to request information about marketing secondary products. The pollution prevention agent can easily search the database for the name of the client (organization). The form will automatically show the user other organizations with similar names to be sure that this client has not already been entered into the database. If the client already exists, the user selects the client, and all relevant client information that has been entered previously appears on the form.

Once the agent has identified the correct client, he or she can move to the project page to scroll through each of the projects already associated with that client to be sure that the request is not associated with an existing project. For example, the same client may have called previously to request the same information, but for some reason that request might not have been completed. The agent can check the status of any existing project and can update information about the project, the client, or the contact.

The contact page of this form contains information about the people at the client organization. Each client can have several contacts. Each project is associated with a contact.

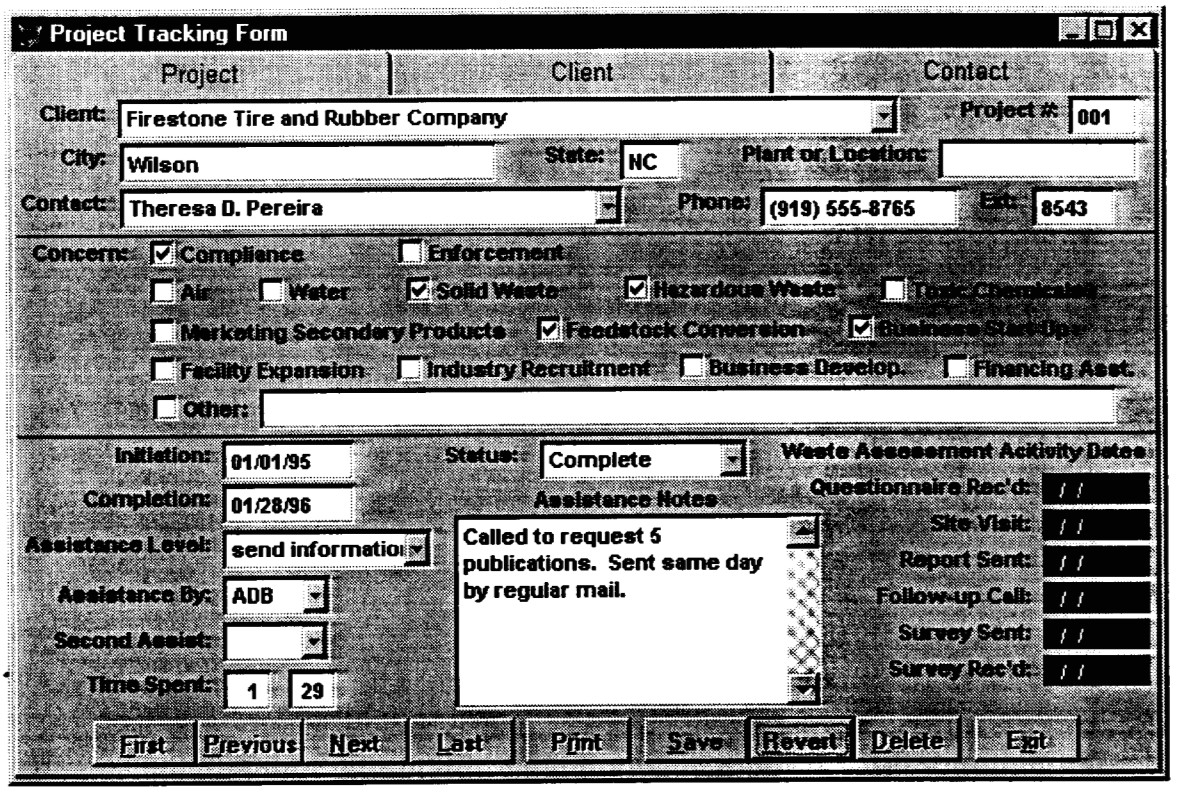

Figure 6-3. Tracker Form, Project Page

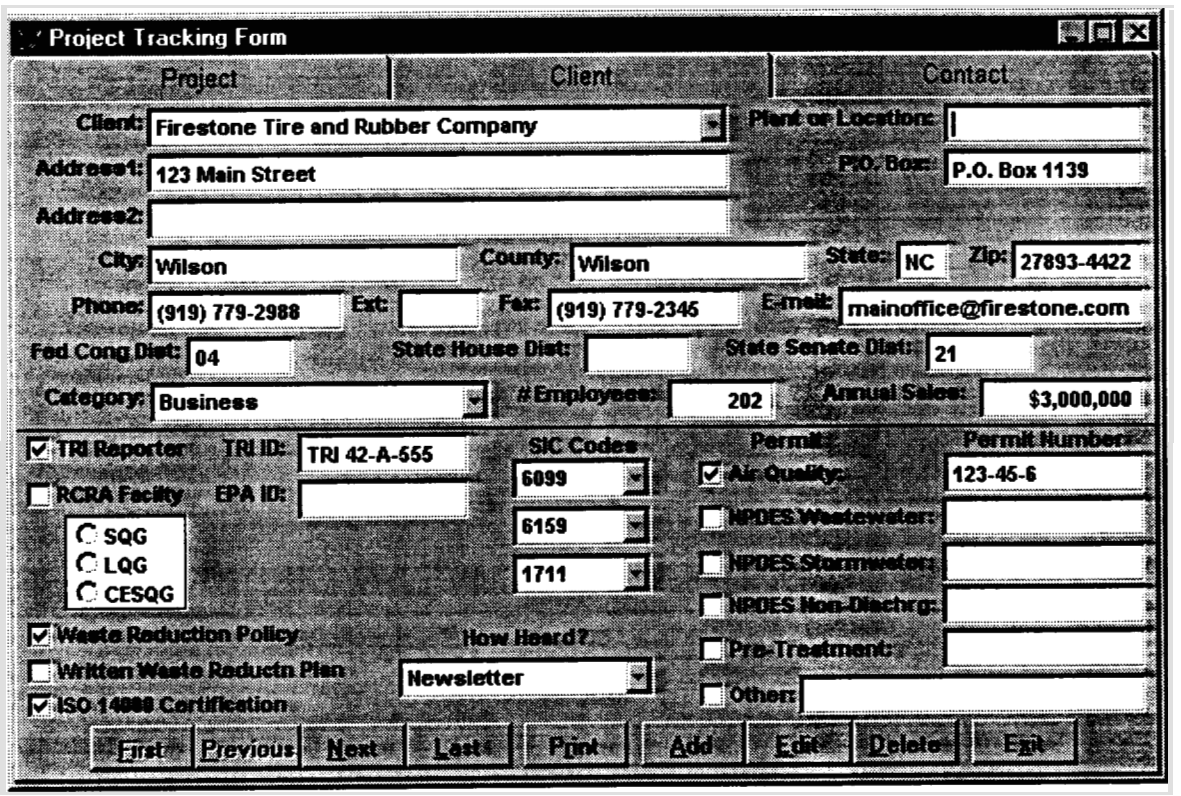

Figure 6-4. Tracker Form, Client Page

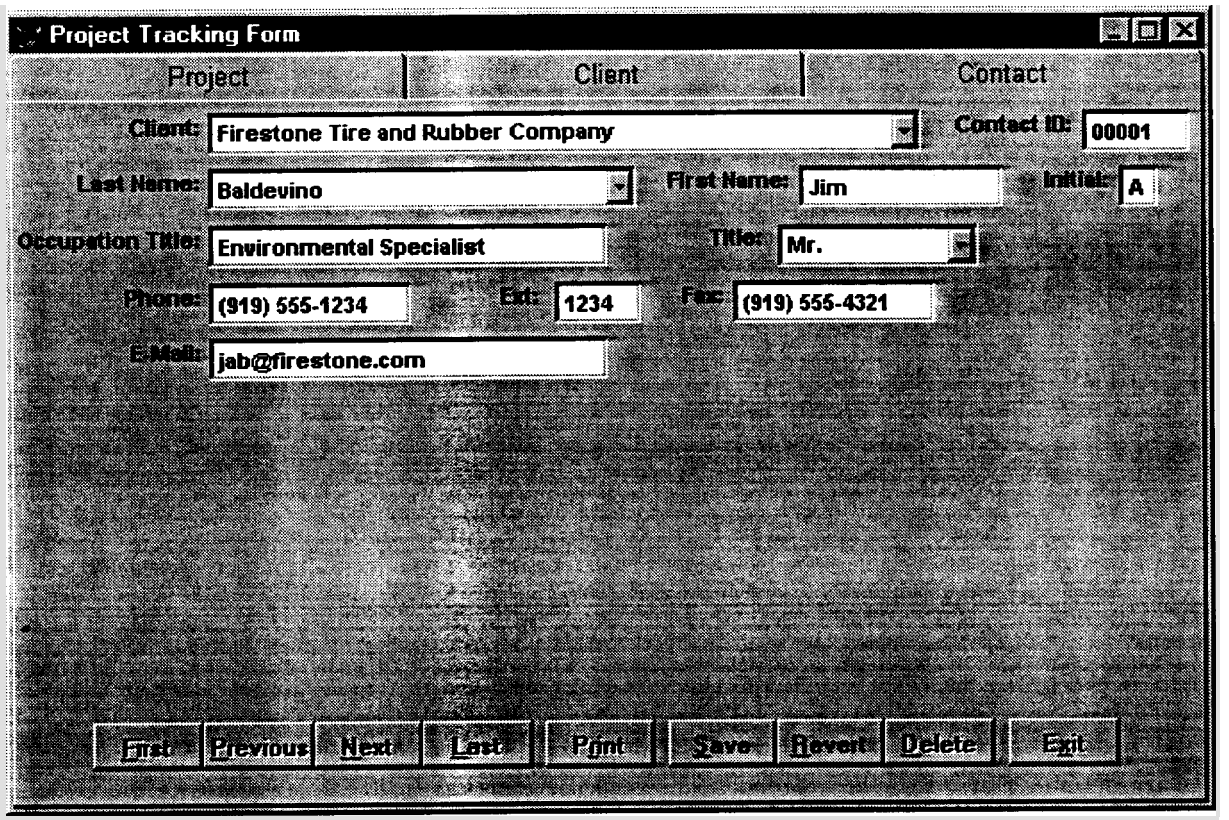

Figure 6-5. Tracker Form, Contact Page

6.3.2.2 Events Form

Figure 6-6 illustrates the events form. It consists of one screen only, and each events table variable appears on the form. The user can browse the screen or add information about new or existing events.

6.3.2.3 Survey Form

The survey form is laid out just as the Customer Follow-up Survey is, in six pages. The user accesses each page by clicking on the appropriate tab. As shown in Figure 6-7, the survey form does not contain all of the text on the paper version of the survey. However, it does contain the labels and headings needed to conveniently enter and browse the data reported by customers in the follow-up survey.

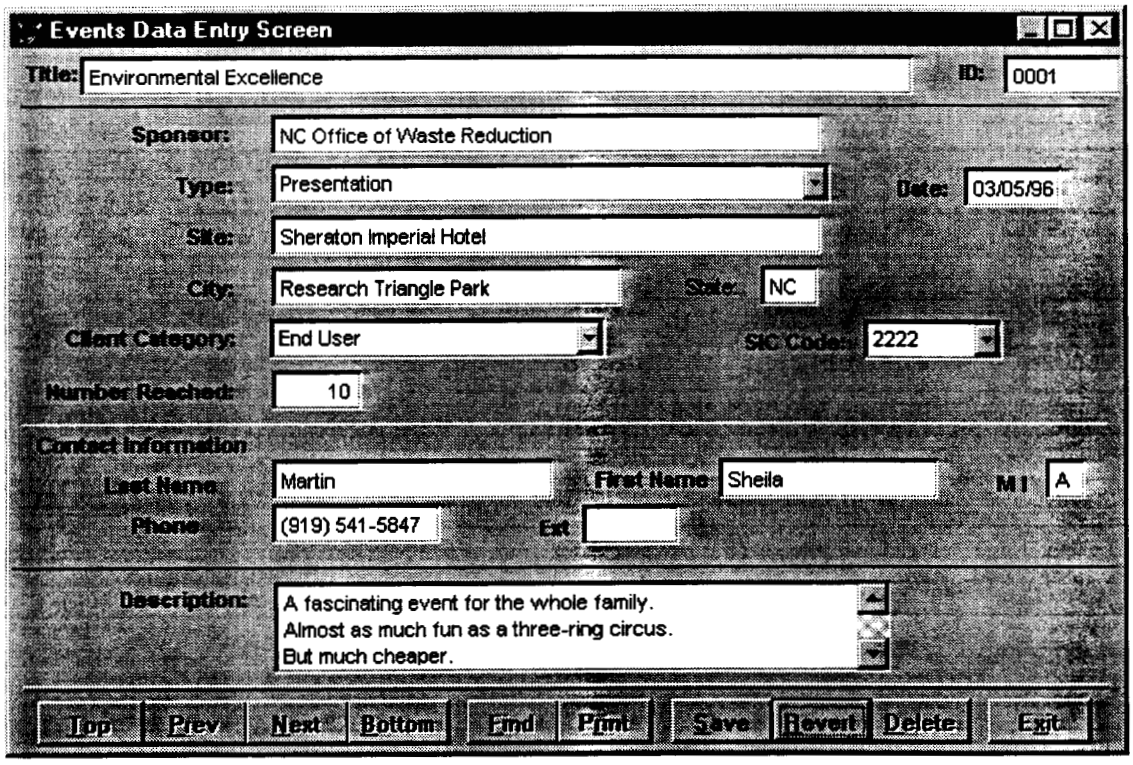

Figure 6-6. Events Form

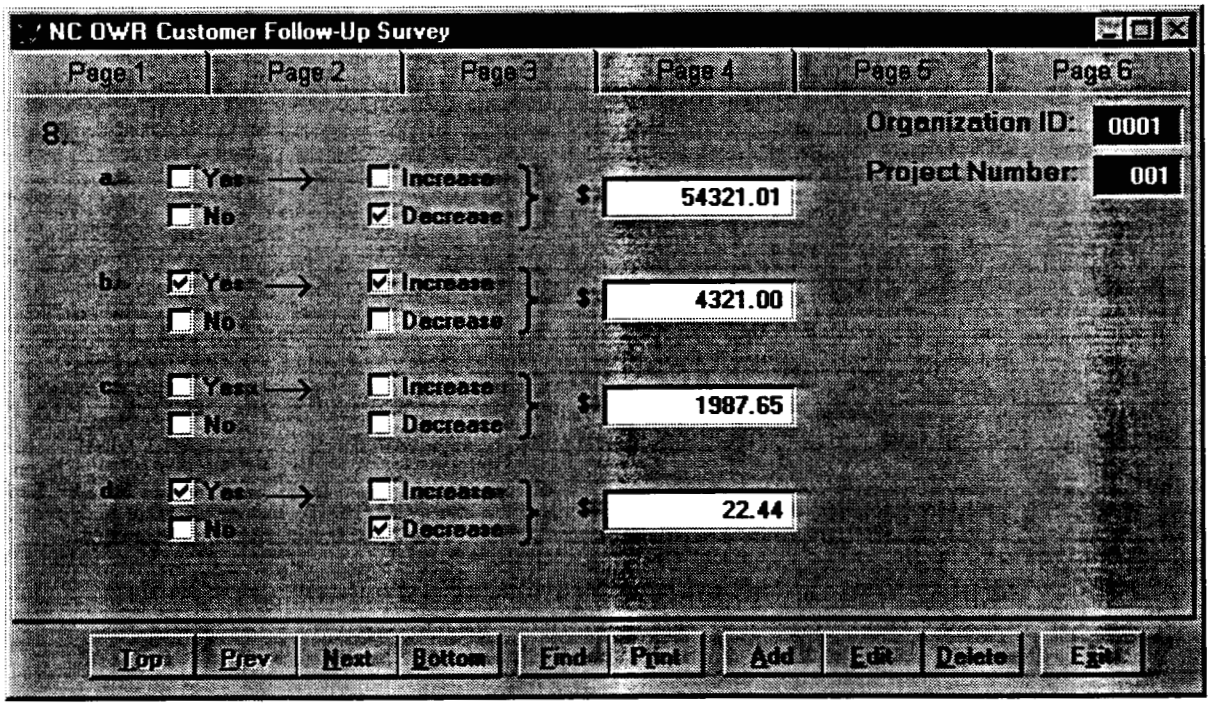

Figure 6-7. Page 3 of the Survey Form

6.3.3 Database Reports

The PPOTAS contains two types of reports:

- single observation reports
- data summary reports

Single observation reports are used to print a single observation from a table. Users generate these reports by clicking the **Print** button on a database form. The PPOTAS contains four of these kind of reports:

- events report
- client report
- project report
- contact report

Data summary reports are generated by running a report specification form that prompts users for parameters needed to run the report. For example, to run the events summary report, users run the form called Eventsum. The dialogue box opens, asking users to provide input, such as start and end dates and variables for analysis. In this case, as shown in Figure 6-8, the only inputs required are the start and the end dates. After filling in the required parameters, users press **Run Report**, and the report is generated. A Microsoft Windows print dialogue box will appear, allowing users the opportunity to change printing options.

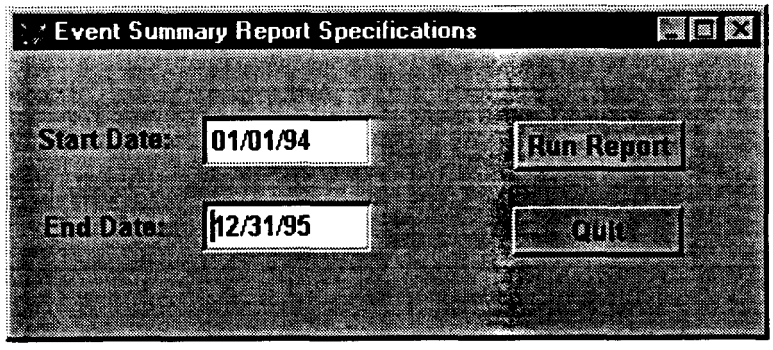

Figure 6-8. The Events Summary Report Specifications Form

The PPOTAS has eight data summary reports. Table 6-2 contains their names, the information they contain, and the forms used to run them.

TABLE 6-2. DATA SUMMARY REPORTS

Report Name	Description	Form Name
Events summary report	Summarizes information from the events table	Eventsum
Activity report	Summarizes project activity over a specified period	Activity
Client summary report	Summarizes information on the client table	Clientsum
Project status report	Provides project status for all projects initiated over a certain period	Projstat
Customer satisfaction report	Summarizes customer satisfaction information from the Customer Follow-Up Survey	Custsat
Economic impact report	Summarizes economic impact information from the Customer Follow-Up Survey	Econimp
Environmental impact report	Summarizes environmental impact information from the Customer Follow-Up Survey	Envimp
Referral report	Summarizes information about the source of referrals to NC OWR	Refer

6.4 SUGGESTED IMPROVEMENTS

With this first release of the PPOTAS, we make note of a number of improvements that could be made to the database, given additional resources.

6.4.1 Improvements in Data Structure

Additional data tables could be added to the PPOTAS to improve its usefulness to pollution prevention outreach offices. First, a publications table, listing reference and location information for each of the publications written by the staff, or routinely sent to clients, would help staff to keep track of what information is routinely requested by each type of client.

Second, an automated time sheet system might be useful in some offices, particularly those that perform many larger-scale projects, such as waste audits. In such a system, outreach agents would record their time by project, and this time would be linked to the project information.

Another improvement in the data structure would be a linkage between the project table and the survey. Ideally, the database would automatically generate a survey after a specified time has elapsed since the client was served. For waste audits, the database would generate the first section of the survey, which refers to specific recommendations from the audits, from information entered into the project table.

Finally, it might be helpful to establish an activity table. Activities would consist of a single engagement with a client. A group of activities that are related to the same problem would be called a project. There would be a many-to-one relationship between activities and projects. While we began to initiate this type of data structure for this project, we found it more complex than what was required for the NC OWR.

6.4.2 Improvements to Forms

The forms that are used to enter and browse data, particularly the tracker form, could benefit from additional detail. For example, it may be useful to require that some fields be filled in so that a person cannot exit the form unless the field is filled in. Similarly, tabbing sequences that skip certain fields when others are set might improve the functionality of the form. For example, in the survey form, in some cases skipping to certain questions based on the answers of preceding questions would be useful.

6.4.3 Improvements to Report Generation Capabilities

The reports we have built for the PPOTAS are simple sums and averages over categories of projects, clients, etc. One potential improvement to these reports would be the development of data crosstabulations. For example, it might be useful to know how many clients employing fewer than 50 people received waste audits. To answer this question, a custom query or report must be run.

A number of customer queries and reports can be devised by users. We tried to provide reports that would satisfy a wide range of data analysis needs. Inevitably, some users will find that they do not meet their needs. Their best course of action is to use the ad hoc query facility of Visual FoxPro and the query and report wizards that allow users to generate a query or report quickly.

REFERENCES

Dillman, Don A. 1978. *Mail and Telephone Surveys*. New York: John Wiley & Sons.

Fagg, Brandon, F., Keith A. Weitz, and John L. Warren. September 1994. *Linking Quantitative and Qualitative Measures for Assessing Environmental Excellence*. Report prepared for the U.S. Environmental Protection Agency, Pollution Prevention Division. Research Triangle Park, NC: Research Triangle Institute.

Goldberg, Terri. August 1993. *Pollution Prevention Measurement at Facilities: Status of the Northeast States' Programs*. Boston: Northeast Waste Management Officials' Association.

Hunt, Gary E. 1990-91. "Waste Reduction Techniques: An Overview." *Pollution Prevention Review* Winter:1-15.

Levitan, Sar A., and Gregory Wurzburg. 1979. *Evaluating Federal Social Programs: An Uncertain Art*. Kalamazoo, Michigan: W.E. Upjohn Institute for Employment Research.

Mark, Melvin M., Irwin Feller, and Amy Glasmeier. 1994. "Evaluation of the Appalachian Regional Commission Industrial Competitiveness Demonstration Projects." Presented at the Manufacturing Modernization: Evaluation Practices, Methods, and Results Workshop, Atlanta, GA, September 18-20.

National Roundtable of State Pollution Prevention Programs. February 1994. *Measuring the Effectiveness of State Pollution Prevention Programs*. Report prepared for the Environmental Protection Agency, Cooperative Agreement No. 817728. Washington, DC.

Oldsman, Eric. 1994. *Evaluating Manufacturing Extension Programs: A Tool for Effective Management*. Cambridge, MA: The Modernization Forum.

Pacific Northwest Pollution Prevention Research Center. May 1994. *Measuring Pollution Prevention Progress: A Report on the Mid-Project Meeting for Measurement Pilot Projects in Alaska, Ohio, Oregon, and Washington*. Seattle, Washington.

Riciardi, Sal. 1994. "Developer Databases: Serious Solutions." *PC Magazine* 13(15):177-226. September 13.

Shapira, Philip, and Jan Youtie. April 1995. ""Assessing GMEA's Economic Impacts: Towards a Benefit-Cost Methodology." Georgia Manufacturing Extension Alliance Evaluation Working Paper E9502.

Shapira, P., J. Youtie, and J.D. Roessner. 1994. "Current Practices in the Evaluation of Industrial Modernization Programs." In *Evaluating Industrial Modernization Programs: Issues, Practices, and Strategies*. Prepared for the Project on the Evaluation of Industrial Modernization Programs: Developing Best Practice. Atlanta: School of Public Policy and Economic Development Institute, Georgia Institute of Technology.

Appendix A
NC OWR Survey

Organization ID: _____
Project Number: _____

NORTH CAROLINA OFFICE OF WASTE REDUCTION
CUSTOMER FOLLOW-UP SURVEY

1. Our records indicate that we suggested the following waste reduction opportunities in a written report sent to you after our site visit. Please indicate whether you have implemented or plan to implement these suggestions by circling the appropriate letter *(Y=Yes, P=Planned)*. If you have not and do not plan to implement the suggestion, circle the letter indicating the reason for your choice not to implement these suggestions.

Identified Waste Reduction Opportunity	Implemented?		Why Not?				
	Yes	Planned	Not Technically Feasible	Low Return on Invest.	Payback Period Too Long	Would Slow Production	Found a Better Solution
a. Review BOD/COP and metal (copper) content of all ingredients used in scouring, bleaching, and dyeing	Y	P	T	R	P	S	B
b. Find substitutes for high BOD/COD ingredients	Y	P	T	R	P	S	B
c. Find substitutes for high copper content ingredients	Y	P	T	R	P	S	B
d. Establish a procedure to prevent excess buildup of lubricant, wax, etc., during the knitting process	Y	P	T	R	P	S	B
e. Establish a material control procedure to account for material use.	Y	P	T	R	P	S	B

2. Approximately how much time did you and your staff spend meeting with the North Carolina Office of Waste Reduction agents and reviewing and implementing their recommendations?

   _____ hours of management time

   _____ hours of production worker time

   _____ hours of outside assistance aside from the North Carolina Office of Waste Reduction (if needed)

3. Were there any direct materials or capital expenses for implementing these recommendations?

   _____ Yes → How much? $_____

   _____ No

4. Before contacting the North Carolina Office of Waste Reduction, did your company employ any of the following environmental management practices? Have you implemented or do you plan to implement these measures since you contacted us? *(Y=Yes, N=No)*

Environmental Management Practices	Before Contact		After Contact	
a. Written environmental policy	Y	N	Y	N
b. Written waste/source reduction policy	Y	N	Y	N
c. Waste reduction/pollution prevention programs	Y	N	Y	N
d. Waste reduction/pollution prevention team	Y	N	Y	N

5. Did the assistance or services you received from the North Carolina Office of Waste Reduction lead to the generation of new waste reduction ideas at your facility?

_____ Yes

_____ No

6. Prior to contacting the North Carolina Office of Waste Reduction, were you concerned that you may have an environmental compliance problem?

_____ Yes → Were these concerns:

_____ Resolved _____ Reduced _____ Unaffected?

_____ No

7. Was any of the information you received from the Office of Waste Reduction shared with sister plants in North Carolina?

_____ Yes → How many? _____

_____ No

8. As a result of the assistance or services you received from our office, or as a result of the waste reduction/pollution prevention measures that you have implemented using the information we provided, have you experienced or do you anticipate any of the following changes?

a. A change in capital spending on plant, equipment, or other capital items (not including the one-time expenses identified in Question 3)?

❑ Yes → If yes, do you expect an increase or decrease? ___ Increase ___ Decrease } Please estimate the dollar value of the increase or decrease. $_____

❑ No

b. A change in labor, materials, energy, or other production costs (do not include capital costs included in 8a)

❑ Yes → If yes, do you expect an increase or decrease? ___ Increase ___ Decrease } Please estimate the annual increase or decrease assuming no change in sales. $_____

❑ No

c. A change in regulatory fees or penalties that you might otherwise have paid?

❑ Yes → If yes, do you expect an increase or decrease? ___ Increase ___ Decrease } Please estimate the annual increase or decrease assuming no change in sales. $_____

❑ No

d. A change in the cost of waste handling, abatement, or disposal?

❑ Yes → If yes, do you expect an increase or decrease? ___ Increase ___ Decrease } Please estimate the annual increase or decrease assuming no change in sales. $_____

❑ No

e. A change in sales (total revenue)?

❑ Yes → If yes, do you expect an increase or decrease? ___ Increase ___ Decrease } Please estimate the annual increase or decrease. $_____

❑ No

f. A change in the quality of your product?

❑ Yes → If yes, do you expect the quality of your product to improve or decline? ___ Improve ___ Decline } Have you or do you expect to change the price of your product as a result of the change in quality? ___ Yes ___ No

❑ No

g. A change in hazardous waste generation?

❑ Yes → If yes, do you expect an increase or decrease? ___ Increase ___ Decrease } Please estimate the annual increase or decrease, assuming no change in production. ____ lb/yr

❑ No

h. A change in nonhazardous solid waste generation?

❑ Yes → If yes, do you expect an increase or decrease? ___ Increase ___ Decrease } Please estimate the annual increase or decrease, assuming no change in production. ____ lb/yr

❑ No

i. A change in air emissions?

❑ Yes → If yes, do you expect an increase or decrease? ___ Increase ___ Decrease } Please estimate the annual increase or decrease, assuming no change in production. ____ lb/yr

❑ No

j. A change in water pollutant discharges?

❑ Yes → If yes, do you expect an increase or decrease?

___ Increase
___ Decrease

Please estimate the annual increase or decrease, assuming no change in production.

____ lb/yr

❑ No

k. A change in the use of hazardous materials?

❑ Yes → If yes, do you expect an increase or decrease?

___ Increase
___ Decrease

Please estimate the annual increase or decrease, assuming no change in production.

____ lb/yr

❑ No

l. A change in water usage?

❑ Yes → If yes, do you expect an increase or decrease?

___ Increase
___ Decrease

Please estimate the annual increase or decrease, assuming no change in production.

____ gal/yr

❑ No

m. A change in energy consumption?

❑ Yes → If yes, do you expect an increase or decrease?

___ Increase
___ Decrease

Please estimate the annual increase or decrease in kWh and cost, assuming no change in production.

___ kWh/yr
$_____ yr

❑ No

9. Given the impact and quality of the services you received from the North Carolina Office of Waste Reduction, what is the maximum amount you would be willing to pay for the services you received? (**Note: the answer to this question will be used to measure the value you place on our services. We are not considering charging for services.**)

$_____

10. How would you rate the assistance and services you received from the North Carolina Office of Waste Reduction? *(Please circle the appropriate number: 1=poor, 3=adequate, 5=excellent)*

	Poor		Adequate		Excellent
a. Staff knowledge and experience	1	2	3	4	5
b. Knowledge of your particular problems and needs (technical competence)	1	2	3	4	5
c. Timeliness (appointments, follow-ups and completion)	1	2	3	4	5
d. Usefulness of final recommendations, reports, and materials	1	2	3	4	5
e. Overall satisfaction with services and assistance	1	2	3	4	5

11. If you knew of a company that had an environmentally related production problem, would you refer then to the North Carolina Office of Waste Reduction?

_____ Yes

_____ No

12. If the services of the North Carolina Office of Waste Reduction had been purchased from a private-sector consultant or firm, what do you estimate the cost of these services would be?

_____ Less than $500

_____ $501 to $1,000

_____ $1,001 to $2,000

_____ $2,001 to $5,000

_____ 5,000 to $10,000

_____ Greater than $10,000

Thank you for your assistance.