RASER RIVER
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Reference Workbook:

Pollution Prevention Plans

Canada

DOE FRAP 1994-35

Environment Canada Environnement Canada

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Pollution Prevention Plans

DOE FRAP 1994-35

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Environmental Protection
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DISCLAIMER

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This Reference Workbook is developed based on pollution prevention and related documents from Environment Canada, United States Environmental Protection Agency, and Washington Department of Ecology. It contains information compiled from several publications including:

Environment Canada National Office of Pollution Prevention
Pollution Prevention: Towards a Federal Strategy for Action (Draft, October 18, 1994)

Ministry of Environment, Lands and Parks
New Directions in Environmental Protection, 5 Year Action Plan 1992 - 1997

Ontario Ministry of Environment and Energy
Pollution Prevention Planning Guidance Document and Workbook, May 1993, (ISBN 0-7778-1441-2)

United States Environmental Protection Agency, Office of Research and Development
Facility Pollution Prevention Guide, May 1992, (EPA/600/R-92/088)

United States Environmental Protection Agency, Office of Research and Development
USER'S GUIDE: Strategic WAste Minimization Initiative (SWAMI) Version 2.0, A Software Tool to Aid in Process Analysis for Pollution Prevention, January 1992, (EPA/625/11-91/004)

Washington Department of Ecology*, Pollution Prevention Planning Guidance Manual, for Chapter 173-307 WAC*, September 1993, (#91-2 Revised)

Washington Department of Ecology, Hazardous Waste and Toxics Reduction Program, *Guidance for Reporting Progress in Pollution Prevention*, March 1994, (93-38)

1.0 II INTRODUCTION

In recent years, governments, companies, and individuals have come to accept that minimizing or avoiding the creation of pollutants and wastes can be more effective in protecting the environment than treating them after they have been created. This source control waste management approach is called pollution prevention.

Pollution prevention is not a new idea. Many manufacturers in North America have already implemented programs to minimize the creation of pollutants at the source. In the early 70's, 3M (Minnesota Mining and Manufacturing) initiated the 3P (Pollution Prevention Pays) Program to provide cash incentive to employees for feasible pollution prevention measures.

The shift in emphasis towards adopting pollution prevention measures by the private sector has been prompted by the continuing increases of waste treatment/disposal costs, promulgation of laws and regulations limiting waste disposal options, and civil/criminal liability. Many companies has found that an effective waste management program that effect waste reduction is a sound business practice in today's manufacturing environment. Companies with improved and effective waste management practices are more likely low cost producers by:

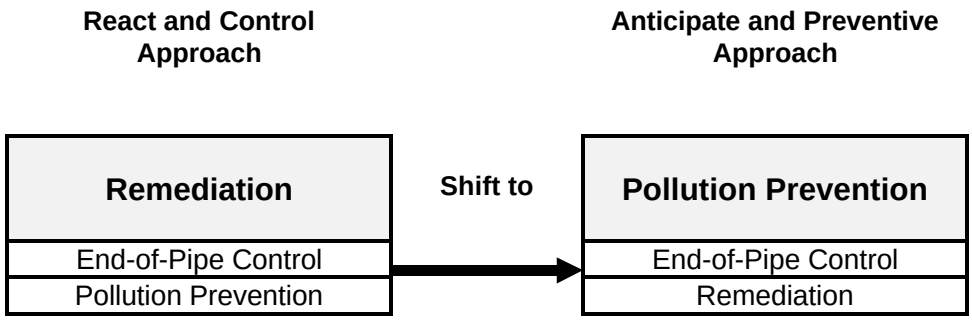
- Minimizing waste treatment costs,
- Avoiding expensive disposal costs, and
- Lowering raw material and/or manufacturing costs.

Many governments have also recognized the positive merits of implementing pollution prevention to minimize the creation of pollutants and lessen the potential threats to human health or the environment. In the United States, environmental regulatory agencies have enacted legislation requiring companies to implement pollution prevention or waste minimization.

Environmental policy in Canada has also begun to shift emphasis from a "control the release of pollutant" policy to pollution prevention. At the federal and provincial levels, strategies are being developed to promote the implementation of pollution prevention practices.

Figure 1.1 presents the environmental protection strategies for the traditional "react and control" approach and the emerging "anticipate and preventive" approach proposed by Environment Canada National Office of Pollution Prevention.

Figure 1.1 Shifting Emphasis for Environmental Protection



As illustrated by Figure 1.1, the environmental protection framework consists of three types of control strategies. These three control strategies are:

- Remediation
- End-of-Pipe Control
- Pollution Prevention

The traditional "react and control" approach emphasizes the role of remediation in the protection of the environment followed by end-of-pipe control and pollution prevention.

Historically, the "react and control" approach to environmental protection has been evolved to address the end-of-pipe performance-based environmental regulations imposed by governmental agencies. With the react and control approach, regulated pollutants from pointed source discharges have been reduced substantially. However, large quantities of non-regulated pollutants are still being discharged to the environment posing substantial future environmental liability. Furthermore, the "react and control" approach failed to control pollutants from non-point pollution sources.

The emerging "anticipate and preventive" approach emphasizes pollution prevention as the predominant strategy for protecting the environment. By avoiding or minimizing the generation of pollutants in the first place, the remaining two strategies, end-of pipe control and remediation can therefore be de-emphasized.

Even though pollution prevention is the preferred strategy, end-of-pipe control and remediation remain integral components within the environmental protection framework proposed by Environment Canada.

In November 1993, the Canadian Council of Ministers of the Environment (CCME) confirmed in *A National Commitment to Pollution Prevention* that

"minimizing or avoiding the creation of pollutants and wastes can be more effective in protecting the environment than treating them, or cleaning them up after they have been created. This approach, called *pollution prevention*, is needed to secure a safe and healthy environment and a sound and prosperous economy. It is a key component of environmental protection and sustainable development."

To advance pollution prevention, member governments of CCME have agreed to undertake the following actions:

- Make pollution prevention the priority;
- Develop and implement government action plans for pollution prevention, and encourage the development of action plans by other sectors;
- Review legislation, regulations and policy as appropriate, and harmonize approaches to pollution prevention;
- Test and implement economic instruments that will help to achieve pollution prevention;
- Educate the public about pollution prevention, and train relevant groups in the technical aspects of pollution prevention;
- Recognize and promote successful pollution prevention initiatives; and
- Develop practical tools, such as guidelines and codes of practice, to enable people to deliver pollution prevention at an operational level.

In support of the CCME pollution prevention initiatives, the British Columbia Ministry of Environment, Lands and Parks, and the Fraser Pollution Abatement Office have taken steps to encourage industries to reduce pollutants discharged to the environment. As a furtherance to promote pollution prevention among governmental agencies and regulated communities, Environment Canada (Industrial Programs Section, EP, Vancouver) has proposed to develop pollution prevention guides for selected industrial sectors in British Columbia Lower Mainland. These guides are designed to assist plant operators in the development of broad-based pollution prevention programs.

2.0 II OBJECTIVE OF THIS REFERENCE WORKBOOK

This Reference Workbook is designed to provide engineering consultants with guidance to develop industrial sector-specific guides for the preparation of pollution prevention plans. These industrial sector-specific guides are designed to provide background information on the manufacturing processes, waste characteristics, and recommended pollution prevention measures. These guides will then be used by individual companies to develop facility-specific pollution prevention plans.

For example, in British Columbia, guides to prepare pollution prevention plans may be developed for the industrial sectors:

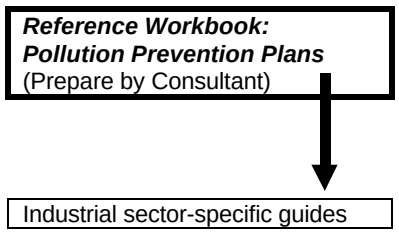
- Saw Mill
- Wood Preservation
- Auto Recycle
- Foundry
- Sand & Gravel
- Metal Smelter
- Scrap Metal
- Cement
- Dry Bulk Terminals
- Ship Yard
- Petroleum Terminal
- Chlor-alkali
- Sodium Chlorate
- Chemical
- Sugar
- Ready-Mix
- Fish Processing
- Meat Processing
- Fruit and Vegetable
- Feed Mill
- Abattoir
- Diary
- Winery
- Brewery

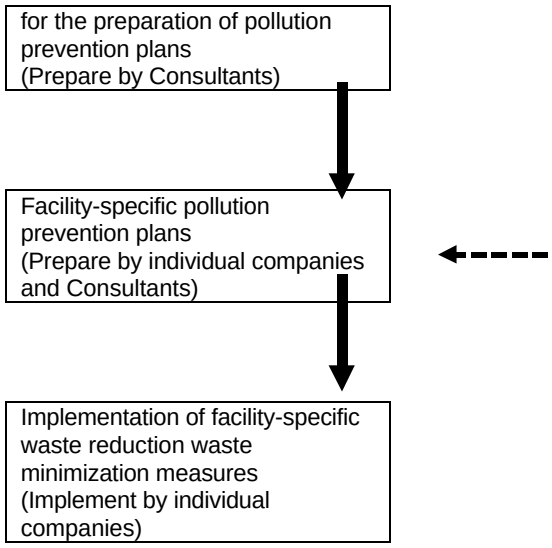
In the absence of an industrial sector-specific guide, this Reference Workbook may also be used to provide a generic basis for consideration of pollution prevention in a plant.

The Reference Workbook presents generically the essential elements in a pollution prevention plan. The industrial sector-specific guides would be developed by following these essential elements and develop/compile detailed process and waste stream information that is characteristic of the industrial sector under consideration. Waste reduction and waste minimization measures would also be identified for plants within this industrial sector. Using the framework and information presented in the industrial sector-specific guides, site-specific pollution prevention plans would be developed for individual plants within the industrial sector. The benefits of the pollution prevention program would be realized with the implementation of the site-specific waste reduction/minimization measures in the pollution prevention plan.

The above steps form the basic components of a pollution prevention program which is illustrated in Figure 2.1.

Figure 2.1 Relationship of Pollution Prevention Components




for the preparation of pollution prevention plans
(Prepare by Consultants)
Facility-specific pollution prevention plans
(Prepare by individual companies and Consultants)
Implementation of facility-specific waste reduction waste minimization measures
(Implement by individual companies)

3.0 II POLLUTION PREVENTION CONCEPT AND BENEFITS

3.1 DEFINITION OF POLLUTION PREVENTION

Pollution prevention is defined by Environment Canada National Office of Pollution Prevention as:

"The use of processes, practices, materials or energy that avoid or minimize the creation of pollutants and wastes without creating or shifting new risks to communities, workers, consumers or the environment."

As defined, pollution prevention emphasizes source reduction measures for all wastes generated at production areas for the protection the environment. It is a multi-media approach which encompasses reduction in air emissions, wastewater discharges, or solid waste. Pollution prevention involves the application of best management practices, product changes, and modifications of manufacturing processes that eliminate or reduce the use of hazardous and non-hazardous materials, energy, water, and/or other resources.

Presented in Table 3.1 are examples of source reduction measures, product changes and process changes, that are classified as pollution prevention measures because they reduce the amount of waste created during production.

Table 3.1 Examples of Pollution Prevention Measures - Source Reduction and Process Changes

Product Changes	• Product reformulation and redesign for less environmental impact • Increase product life
Input Material Changes	• Materials or feedstock substitution • Avoid or minimize the use of toxic materials • Substitution with less toxic materials
Technology Changes	• Redesign equipment layout to minimize looses • Change to mechanical stripping/cleaning to minimize solvent usage • Increase automation/improved equipment to improve operating efficiencies • Process/technology modification • Install equipment to reduce energy consumption
Best Management Practices	• Improve operator training • Improve operation & maintenance procedures • Improve housekeeping practices • Eliminate sources of leaks • Improve inventory control to minimize disposal of outdated materials • Implement segregation of flows to minimize cross-contamination and to facilitate reuse and/or recycling

Traditional end-of-pipe treatment or waste management treats the wastes after they have been generated. It is a single medium approach designed to address performance-based environmental regulations.

Presented in Table 3.2 are examples of traditional approach to environmental protection that are not pollution prevention measures.

Table 3.2 Examples of Traditional Pollution Control Measures - Not Pollution Prevention Measures

Recycling Outside of the Waste Generating Process	• Off-site reuse and recycling • Waste exchanges • Off-site reclamation
Waste Treatment	• Physical, chemical, and biological treatment • Evaporation • Incineration • Solidification/stabilization
Disposal	• Discharge to the receiving environment • Discharge through sewers • Landfill • Waste processing facility

3.2 BENEFITS OF POLLUTION PREVENTION

With the continuing increases of performance-based regulations, the traditional end-of-pipe single medium approach generally resulted in increasingly complex treatment technologies that inevitably pushes up compliance costs. Furthermore, it often simply transfer pollutants from one medium to another. In contrast, pollution prevention can address more effectively and efficiently multi-media impacts (air, water, solid waste, and energy) from facilities or processes via source reduction measures. Furthermore, pollution prevention encourages creative pollution control efforts thereby minimizing non-production related capital and operational costs.

By minimizing the amounts of waste generated at the source, pollution prevention approach allows for the reduction of labor and equipment required for waste treatment. In addition to reduction in waste treatment costs, pollution prevention offers other benefits, both tangible and intangible. These benefits include:

- reduced waste treatment and disposal costs;
- improved business efficiency and profitability;
- improved company image;
- reduced regulatory compliance costs;
- reduced future cleanup costs;
- reduced future risk of liability; and
- reduced risk to workers and to the community.

3.3 ENVIRONMENTAL MANAGEMENT HIERARCHY

Notwithstanding the many benefits inherent in pollution prevention measures, these measures alone will not eliminate all pollution in the environment. Other traditional waste management methods are still needed and should not be excluded from a comprehensive environmental protection program.

As such, Environment Canada National Office of Pollution Prevention in the "anticipate and prevent" strategy recognizes pollution prevention is the first step in a hierarchical approach for the protection of the environment. Other waste treatment techniques including recycling, treatment, and disposal are lower in priority.

Table 3.3, presented below, illustrates the priority of pollution prevention within the environmental management hierarchy.

Table 3.3 Hierarchical Structure of Environmental Management

Waste Management Approach	Implementation Priority	Management Method	Example Applications
Pollution Prevention Measures	1 (Highest)	• Source Reduction	• Modify product to eliminate solvent
	2	• On-site Reuse Recycling	• Capture and return vapor to process
Traditional End-of-pipe Treatment Methods	3	• Off-site Reuse Recycling	• Solvent recovery at an off-site facility
	4	• Material and/or Energy Recovery	• Boiler for energy recovery
	5	• Residual Waste Management	• Land disposal

As illustrated by Table 3.3, the highest priorities are assigned to preventing pollution through source reduction and reuse, or closed-loop recycling. Other non-pollution prevention measures such as traditional end-of-pipe treatment methods are ranked lower in the implementation priority.

4.0 II POLLUTION PREVENTION STRATEGIES

4.1 CANADA

In *A National Commitment to Pollution Prevention*, the Canadian Council of Ministers of the Environment in November 1993 affirmed the importance of pollution prevention in environmental protection and sustainable economic development.

The National Office of Pollution Prevention, Environment Canada, in *Pollution Prevention: Towards a Federal Strategy for Action* (Draft, October 18, 1994), also re-affirmed the federal government's commitment to pollution prevention. The strategy outlined an action plan containing federally driven initiatives to promote pollution prevention in each of the five target sectors:

- Federal government
- Provinces
- Industry
- Small business and individuals
- International community.

The elements of this action plan are summarized and presented in Table 4.1.

Table 4.1 Federal Pollution Prevention Action Plan

Federal Government	• Incorporate pollution prevention into federal government priorities • Incorporate pollution prevention into federal legislation • Establish and implement green policies • Establish commissioner of the Environment and Sustainable Development • Apply principles of pollution prevention to departmental priorities
Provinces	• Develop practical tools, such as guidelines and codes of practice, to enable people to implement pollution prevention at an operational level • Review legislation, regulations and policy for opportunities to harmonize approaches to pollution prevention • Inform the public about pollution prevention, and train relevant groups in the technical aspects of pollution prevention
Industry	• Promote pollution prevention in the environmental industries sector through the Canadian Environmental Industry Strategy • Seek industry input in the implementation of economic instruments that will help achieve pollution prevention • Determine the potential for comprehensive environmental performance contracts • Promote the development and implementation of industrial processes based on "Green Chemistry"
Small Business and Individuals	• Encourage use of purchasing power to promote pollution prevention through EcoLogo

Table 4.1 Federal Pollution Prevention Action Plan	
	• Domestic market development initiative to improve environmental performance
International Community	• Strengthen promotion of pollution prevention in international standards • Advance pollution prevention through international protocols and agreements

4.1.1 Province of British Columbia

The Ministry of Environment, Lands and Parks in *New Directions in Environmental Protection, 5 Year Action Plan 1992 - 1997* sets out new approaches to achieve the program's goal of zero pollution. This Action Plan represents a major change in the traditional regulatory approach to environmental protection, which attempted to deal with pollution after it occurred.

Key activities of this Action Plan are:

- Implementing pollution prevention and the 5R waste management hierarchy (Reduce, Reuse, Recycle, Recover, Residual Management);
- Setting and enforcing pollution standards;
- Regulating waste discharge, including hazardous wastes;
- Monitoring and inspecting discharges and the ambient environment;
- Developing market-based incentives to reduce pollution, including user-pay practices; and
- Providing public information and education on pollution issues.

Under this program, both the private sector (industry and business) and the public sector (municipal and provincial governments) are required to develop 5 year plans for pollution prevention and the 5R waste management hierarchy.

4.1.2 Province of Ontario

The Ontario Ministry of Environment and Energy has shifted to the pollution prevention approach for environmental management. For the past two years, the Ministry has been working with the private sector in pollution prevention planning and implementation.

Currently, the Ministry of Environment and Energy has pollution prevention planning and implementation agreements with:

- Motor vehicle manufacturing sector (Chrysler, Ford, and General Motors);
- Auto parts manufacturing sector (10 companies);
- Metal finishers (6 companies);
- Chemical manufacturers (6 companies);
- Printing and graphics industry (5 companies);
- Industrial laundries (10 companies);
- Photo processing (6 companies); and
- Food processing (6 companies).

4.2 UNITED STATES

At the federal government level, hazardous waste reduction programs are required under the 1988 Resources Conservation and Recovery Act (RCRA), the 1990 Pollution Prevention Act (PPA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

In addition to hazardous wastes, the PPA encourages and emphasizes source reduction, closed-loop waste recycling, and/or reuse of all types of wastes. End-of-pipe treatment and disposal are only considered as methods of last resort.

At the state government level, many states have also enacted pollution prevention legislation. As of June 1993, 33 states had enacted such legislation.

To further promote pollution prevention, the United States Environmental Protection Agency (USEPA) has incorporated such strategy in the proposed air and water regulations for the pulp and paper industry (Federal Register, Vol. 58, No. 241, December 17, 1993). The goal of the regulations is to drive the industry to make process changes instead of end-of-pipe and add-on controls. Anticipated process changes include: extended cooking, oxygen delignification, brownstock washing, boiler upgrades, and high chlorine dioxide substitution. The regulations are expected to be promulgated in the fall of 1995.

4.2.1 State of Washington

In the State of Washington, the 1990 Legislature passed the Hazardous Waste Reduction Act. This act encourages voluntary efforts to redesign industrial, commercial, production, and other processes to reduce or eliminate hazardous waste. This act set a statewide goal of reducing the generation of hazardous waste by 50 percent by 1995. To achieve this goal, the act requires certain hazardous waste generators and hazardous substance users to prepare plans for voluntarily reducing hazardous substance use and hazardous waste generation.

The plan must consider pollution prevention opportunities based on hazardous substances and waste reduction priorities established by the Hazardous Waste Reduction Act. The selection priorities are:

- Reduce hazardous substances use or reduce hazardous waste generation
- Recycling of waste
- Treatment

This hierarchical approach requires waste treatment should only be considered when reduction and recycling are determined to be inappropriate.

In addition to the pollution prevention plan, the law also requires each affected facility to submit:

- Executive Summary containing key information from the reduction plan;
- Annual Report to evaluate progress made in achieving performance goals; and
- Updates of the plan must be submitted every five year.

4.3 SUMMARY

There are many common features among the pollution prevention strategies discussed above. All of the strategies emphasize:

- The importance of pollutant reduction; and
- The role of pollution prevention plans in the identification and evaluation of pollution prevention opportunities.

Differences in these strategies are in the types of waste targeted and in the preparation of the pollution prevention plans.

Under the B.C. program, both the private sector (industry and business) and the public sector (municipal and provincial governments) are required to develop 5 year plans for pollution prevention and the 5R waste management hierarchy.

In the United States, both the USEPA and the state environmental regulatory agencies such as Washington Department of Ecology require the preparation of pollution prevention plans. Both of these programs encourage voluntary efforts to reduce and/or eliminate waste generation. The Washington program targets only hazardous waste.

5.0Þ ESSENTIAL ELEMENTS OF POLLUTION PREVENTION PLANS

Presented in this section are the essential elements of pollution prevention plans. The information presented for these element is generic and is applicable for all industrial facilities. The pollution prevention plan development guides will provide industrial sector-specific information to assist industrial facilities to prepare site-specific pollution prevention plans.

The essential elements of pollution prevention plans are:

- **Industry Profile**
- **Environmental Review**
- **Detailed Assessment**
- **Pollution Prevention Progress Assessment**

The pollution prevention plan development guides will need to provide industrial sector-specific information for these elements.

5.1 INDUSTRY PROFILE

An industry profile is a characterization of the various industries within the industrial sector under consideration. The industry profile contains information on:

- **Industry Description**
- **Raw Materials**
- **Process Description**
- **Products**
- **Waste Materials**
- **Waste Management Methods**
- **Environmental Permit Requirements and Performance**

Presented in Table 5.1 is a summary of the information required to fully characterize each industrial sector.

Table 5.1 Industry Profile	
Category	**Typical Information**
Industry Description	• Listing of industries within the industrial sector including SIC Codes • The number of facilities in the geographical region of interest, e.g., Lower Mainland
Raw Materials	• Raw Materials • Active Ingredients or Components of Concern • Loading and Unloading Methods • Storage Conditions
Process Description	• Unit Operations, Integrated Processing • Equipment • Operating Schedule/Periods • Energy
Products	• Intermediate Products • Finished Products • Active Ingredients or Components of Concern • Product Storage
Waste Materials	• Waste Materials (media) • Waste Stream Origin • Active Ingredients or Components of Concern • Hazardous Properties
Waste Management Methods	• Material Storage Method • Process Location (indoor/outdoor) • Treatment/Disposal Methods • Reduction, Recycling, and Treatment Activities • Best Management Practices
Environmental Permit Requirements	• Applicable Permits (wastewater, air, special waste, or solid waste) • Discharge/Emission Data • Performance

The industrial background information is available from a variety of sources. Most commonly available sources include technical reports from industry associations, government agencies, such as: USEPA, British Columbia Ministry of Environment, Lands and Parks (BCMOELP), Greater Vancouver Regional District (GVRD), and Environment Canada.

For example, Environment Canada developed Code of Practice/Best Management Practice Guides for several industrial sectors. The following is a listing of the Code of Practice/Best Management Practice Guides:

- *Ready Mix Concrete Industry Environmental Code of Practice*
- *Best Management Practice Guide for British Columbia Dry Bulk Terminals*
- *A Review of Stormwater Management Practices at Petroleum Product Bulk Terminals*
- *A Practical Manual of Waste Treatment for Small Metal Finishing Operators*
- Coal Dust Control

- Anti-Sapstain Wood Preservation
- *Wastewater Characterization of Fish Processing Plant Effluent*
- *Guide for the Best Management Practices - Storm Water Management for Selected Industrial Sectors in the Lower Fraser Basin*
- *Recommended Environmental Best Management Practices for Ship and Boat Building and Repair Facilities in British Columbia*

Permit and pollutant discharge information for the industry profile should be compiled from environmental regulatory permits and discharge/emission monitoring reports. For Lower Mainland industrial facilities, permits and monitoring reports are available from Environment Canada, BCMOELP, and GVRD.

Other background information for the industry profile may be compiled from other Canadian federal and provincial documents, the United States Environmental Protection Agency's effluent limitations development documents and guides to pollution prevention, state environmental agencies documents, and National Technical Information Service (NTIS) documents.

Presented in Tables 5.2 and 5.3 are listings of USEPA effluent limitations development documents and the pollution prevention guides applicable for the industrial sectors under consideration in the Lower Fraser Basin.

Table 5.2 Selected USEPA Effluent Limitations Development Documents

Category of Studies	Subcategory	Document Number
Fruit & Vegetables	Fruit & Vegetables Specialties	EPA 440/1-75/046
Organic Chemicals	Segment of Organic Chemicals	EPA 440/1/-75/045
Inorganic Chemicals Manufacturing	Inorganic (Phase I) Proposed Inorganic Chemicals - Phase II (Final)	EPA 440/1-79/007-b EPA 440/1-84/007
Petroleum Refining	Petroleum (Draft)	EPA 440/1-76/083-a
Nonferrous Metals Manufacturing	Secondary Aluminum	EPA 440/1-76/081-c
Phosphate	Non-Fertilizer Non-Fertilizer (Proposed)	EPA 440/1-75/043 EPA 440/1-82/029
Timber Products	Plywood & Wood (Draft) Timber Products (Final)	EPA 440/1-74/023-a EPA 440/1-74/034
Metal Finishing	Metal Finishing (Final)	EPA 440/1-83/091
Foundries	Metal Molding (Proposed) Metal Molding (Final)	EPA 440/1-82/070-b1 EPA 440/1-82/070-b2 EPA 440/1-85/070
Coil Coating	Coil Coating - Phase I (Proposed) Coil Coating - Phase II (Final)	EPA 440/1-81/071-b EPA 440/1-83/071-b
Nonferrous Metals	Nonferrous Metals Forming and Metal Powders (Volume I-III) (Final)	EPA 440/1-86/019

Table 5.3 USEPA Pollution Prevention Guides	
Industrial Category	**Document Number**
Pesticide Formulating	EPA/625/7-90/004
Paint Manufacturing	EPA/625/7-90/005
Fabricated Metal Products	EPA/625/7-90/006
Printed Circuit Board Manufacturing	EPA/625/7-90/007
Commercial Printing	EPA/625/7-90/008
Selected Hospital Waste Streams	EPA/625/7-90/009
Research and Educational Institutions	EPA/625/7-90/010
Photoprocessing	EPA/625/7-90/012
Automotive Repair	EPA/625/7-91/013
Fiberglass Reinforced and Composite Plastics	EPA/625/7-91/014
Marine Maintenance and Repair	EPA/625/7-91/015
Automotive Refinishing	EPA/625/7-91/016

In the absence of code of practice, BMP guide, effluent limitations development document, or other relevant documents, the industrial profile background information should be complied based on site inspections of representative facilities in the Lower Fraser Basin.

5.2 ENVIRONMENTAL REVIEW

The purpose of environmental review for an industrial facility is to identify all waste streams, their sources and the costs of treatment and disposal for an industrial facility. The information is then used to identify areas of opportunity for pollution prevention as described in the subsequent detailed assessment program.

The environmental review program is designed to provide a focus for consideration of pollution prevention and to minimize data collection/pollution prevention evaluation costs. The tasks for the environmental review program are:

Task 1 Plant Data Compilation
Task 2 Site Inspection
Task 3 Identification of Pollution Prevention Potentials
Task 4 Prioritization of Pollution Prevention Potentials

5.2.1 Plant Data Compilation

Plant data compilation, in an all-media approach, involves considering all waste streams, identifying their sources and quantifying the costs of pollution control, treatment, and waste disposal.

The plant data compilation program will depend on the size of the plant and/or the complexity of the production processes. For smaller facilities with limited waste streams and/or limited process modification options, the program will simply consist of compiling existing information using normal plant operating data and waste discharge monitoring data. For larger facilities with complex production processes and multiple waste streams, the program may need to include data from each process and/or waste stream. A sampling and analytical program may need to be conducted if these data are not available from existing information sources.

The data requirements for the plant data compilation program are presented in Table 5.4.

Table 5.4 Environmental Review - Plant Data Compilation Program	
Category	**Facility-Specific Information**
Raw Materials	• Raw Materials (type, usage, cost) • Active Ingredients or Components of Concern • Loading and Unloading Methods • Storage Conditions
Process Description	• Unit Operations, Integrated Processing • Equipment • Operating Schedule/Periods • Energy (type, cost)
Products	• Intermediate Products • Finished Products • Active Ingredients or Components of Concern • Product Storage
Waste Materials	• Waste Materials (type and quantity) • Waste Stream Origin • Active Ingredients or Components of Concern • Hazardous Properties
Waste Management Methods	• Material Storage Method • Cost of Waste Management • Process Location (indoor/outdoor) • Treatment/Disposal Methods • Reduction, Recycling, and Treatment Activities • Best Management Practices
Environmental Permit Requirements	• Applicable Permits (wastewater, air, special waste, or solid waste) • Discharge/Emission Data • Performance

There are a number of information sources to consider. Presented in Table 5.5 are sources that may provide the necessary facility-specific information.

Table 5.5 Data Sources for Facility-Specific Information	
Regulatory Information	• Waste shipment manifests • Emission inventories • Hazardous waste storage reports Waste, wastewater, and air emissions analyses • Environmental audit reports • Discharge permits and monitoring reports
Process Information	• Process flow diagrams • Design and actual material and heat balances for production processes • Design and actual material and heat balances for pollution

Table 5.5 Data Sources for Facility-Specific Information	
	control processes • Operating manuals and process descriptions • Equipment lists • Equipment specifications and data sheets • Piping and instrument diagrams • Plot and elevation plans • Equipment layouts and logistics
Raw Material/Production Information	• Product composition and batch sheet • Material application diagrams • Material safety data sheets • Vendor/supplier data sheets Product and raw material inventory records • Operator data logs • Operating procedures • Production schedules
Accounting Information	• Waste handling, treatment, and disposal costs • Water and sewer costs • Non-hazardous waste disposal costs Product, energy, and raw material costs • Operating and maintenance costs • Revenue

Depending on facility-specific conditions, the results of the plant information compilation program are generally presented by mass balances for waste components of concern, plant flow diagram(s) showing the types and quantities of all raw materials entering and all products and wastes leaving the plant, and the treatment and disposal of the wastes in all media (air, water, solid waste).

5.2.2 Site Inspection

Site inspection should be used to review the accuracy of the information collected and to identify missing or poorly documented information.

The site inspection should be well-planned to ensure that maximum benefit is obtained. Several suggestions for preparing and conducting site inspection are presented below:

- Review existing documentation
- Decide on data collection formats
- Prepare a site inspection agenda
- Interview operators and supervisors
- Follow the process from beginning to end
- Make follow-up site inspections.

The results of the site inspection should be used to update the mass balances and process flow diagrams and to finalize the plant data compilation program.

5.2.3 Identification of Pollution Prevention Potentials

Based on the mass balances and process flow diagrams, potential pollution prevention areas may be identified for the subsequent phase of the detailed assessment.

Facility-specific criteria should be developed to select potential process areas and waste streams for implementing pollution prevention measures. Typically, production areas, raw materials, or waste materials that incur high manufacturing cost, high waste volume, or high disposal cost are targeted as potential areas for detailed assessment.

Presented in Table 5.6 are typical criteria that need to be considered for selecting and prioritizing process areas and waste streams for detailed assessment.

Table 5.6 Typical Criteria for Selecting and Prioritizing Process Areas and Waste Streams for Detailed Assessment

Regulatory	• Compliance with current and anticipated environmental regulations • Required chemicals or feedstocks to be banned or phased out by governmental regulations • Impacts to environment • Potential environmental and safety liability • Hazardous properties of the waste (including toxicity, flammability, corrosivity, and reactivity)
Process/Operation	• Potential for removing bottlenecks in production Potential recovery of valuable by-products • Maintaining product quality • Compatibility of the new equipment, materials, or procedures with current mode of operations • Additional labor requirement • Impact to current operation during system implementation • Minimizing wastewater discharges • Reducing or alternate energy use • Potential impacts to other receiving environments
Waste Management	• Costs of waste management (pollution control, treatment, and disposal) • Quantity of waste Potential for removing bottlenecks in waste treatment • Potential for implementing on-site reuse or recycling
General	• Safety hazards to employees • Impact to public health

5.2.4 Prioritization of Pollution Prevention Potential

Based on the facility-specific criteria developed in Section 5.2.3, the identified potential process areas and waste streams should be prioritized for detailed assessment.

The Weighted Sum Method or a similar quantitative method may be used to rank the identified potential process areas and waste streams. This method first assigns a weighting factor for each of the criteria in relation to their importance (use the facility-specific criteria developed in Section 5.2.3). Each waste stream is then rated on each criterion. Finally, the

rating of each waste stream for a particular criterion is multiplied by the weight of the criterion. The waste stream's overall rating is the sum of the products of rating times the weight of the criteria.

Presented in Table 5.7 is an example of the weighted sum method for prioritizing waste streams or process areas for detailed pollution prevention assessment.

Table 5.7 Weighted Sum Method for Prioritizing Waste Streams or Process Areas

Waste Stream Prioritizing Criteria	Relative Weight (W)	Score Stream 1 (S1)	Weighted Score Stream 1 (WxS1)	Score Stream 2 (S2)	Weighted Score Stream 2 (WxS2)	Score Stream 3 (S3)	Weighted Score Stream 3 (WxS3)
Environmental Regulations Compliance	9	2	18	5	45	5	45
Hazardous Properties of the Waste	5	10	50	2	10	2	10
Impacts to Environment/Public Health	5	5	25	2	10	2	10
Quantity of Waste Generated	10	10	100	10	100	5	50
Waste Treatment/Disposal Costs	10	10	100	10	100	5	50
Potential Future Liability Reduction	7	10	70	3	21	2	14
Other Waste Management Potential	5	2	10	10	50	10	50
Safety of Employees	8	8	16	3	24	2	16
Sum of Criteria Scores (✦(W⍙S))			389		360		245

The above example uses a scale of 0 to 10 for ranking each of the criteria and waste stream in relation to their importance with 0 for low and 10 for high. For this example, Stream 1 rates the highest with a score of 389. Stream 2's score is 360 and Stream 3's score is 245. In this case, if resources are limited, Stream 1 should be selected for the detailed phase of the assessment, for the identification of pollution prevention options.

5.3 DETAILED ASSESSMENT

The objective of detailed assessment is, based on the prioritized list of waste streams from environmental review, to identify appropriate pollution prevention options for implementation. These pollution prevention options must also be evaluated to ensure that they are technically, environmentally, and economically feasible to be considered for implementation.

To maximize available resources, emphasis should be focused initially on the high ranking waste streams or process areas. Lower priority waste streams or process areas should also be evaluated but implementation may be executed at a later stage.

The tasks for the detailed assessment program are:

Task 1 Process and Waste Treatment Data Collection
Task 2 Organization and Documentation of Process and Waste Stream Data
Task 3 Process and Waste Treatment Data Review and Site Inspection
Task 4 Identification and Screening of Pollution Prevention Options
Task 5 Feasibility Assessment
Task 6 Assessment Report Preparation

5.3.1 Process and Waste Treatment Data Collection

This task characterizes in detail the process areas with high pollution prevention potential waste streams identified in the environmental review phase.

A multi-media approach, which encompasses air, water, and solid waste should be used to quantify the total waste loads discharged from each targeted process area. Because the detailed assessment phase of the program concentrates on targeted production processes, operations, or waste streams, additional data such as intermediate stream chemical characteristic data will need to be collected. A sampling and analytical program may need to be conducted if these data are not available from existing information sources.

Presented in Table 5.8 are data requirements for characterizing manufacturing processes or unit operations.

Table 5.8 Process Data Collection Requirements

Manufacturing Process/Unit Operation		
• Process Description • Operation Type (Continuous, Batch, Other) • Operating Schedule • Labor Usage	• Labor Cost • Energy Usage • Energy Cost • Operation and Maintenance Costs	
Input Feed Materials	**Waste Streams**	**Products**
• Material Name/Description • Source/Supplier • Active Ingredients or Component of Concern • Hazardous Properties • Media (Gas, Liquid, Solids) • Usage Rate • Unit Cost • Delivery Mode • Shelf Life or Storage Life • Alternate Feed Materials	• Waste Name/Description • Active Ingredients or Component of Concern • Hazardous Properties • Media (Gas, Liquid, Solids) • Generation Rate • Fate of Waste (Off-site Disposal, On-site Treatment, Blending, Recycle) • Waste Management Costs	• Product Name/Description • Product Type (Final, interim) • Hazardous Properties • Media (Gas, Liquid, Solids) • Product Rate • Revenue

As shown above, the required data are organized into the following categories:

- Manufacturing Process/Unit Operation
- Input Feed Materials
- Waste Streams
- Products.

This organization accounts for the incoming and outgoing streams in a unit operation and is designed to facilitate data analysis and the preparation of material balances.

Detailed data requirements for waste treatment systems are presented in Table 5.9.

Table 5.9 Waste Treatment System Data Collection Requirements

Waste Treatment System		
• Process Description • Operation Type (Continuous, Batch, Other) • Operating Schedule • Labor Usage • Labor Cost	• Energy Usage • Energy Cost • Treatment Facility Cost • Operation and Maintenance Costs	
Input Chemicals/Materials	**Input Wastes**	**Output Wastes**
• Material Name/Description • Source/Supplier	• Waste Name/Source • Active Ingredients or Component of Concern	• Waste Name/Description • Active Ingredients or Component of Concern

Table 5.9 Waste Treatment System Data Collection Requirements		
• Hazardous Properties • Media (Gas, Liquid, Solids) • Usage Rate • Unit Cost • Delivery Mode • Shelf Life	• Hazardous Properties • Media (Gas, Liquid, Solids) • Input Rate	• Hazardous Properties • Media (Gas, Liquid, Solids) • Generation Rate • Fate of Waste (Off-site Disposal, On-site Treatment, Blending, Recycle) • Waste Disposal Costs

5.3.2 Organization and Documentation of Process and Waste Treatment Data

The unit operation and/or waste treatment system data should be complied to prepare mass balances for waste components of concern. A material balance should be calculated for each waste component of concern and for each targeted unit operation or an entire process.

A mass or energy balance is used to account for the flow, generation, consumption, and accumulation in a process. Mathematically, the mass or energy balance, which is based on the law of conservation of matter, can be expressed as:

Input = Output + Accumulation

Mass balance calculations are useful for organizing process data. However, the accuracy of the results depends on the quality of the data used for the calculations. Due to inaccurate or non-representative process data, mass balance calculations for many manufacturing processes will be incomplete, approximate, or both. Factors that contribute to incomplete or approximate mass balance calculations include:

- Numerous process streams, many of which affect various environmental media.
- Exact composition and flow rates of many streams are not known and cannot be determined easily.
- Chemical reactions and/or phase changes occur within the process requiring multi-media analysis and correlation.
- Non-steady state plant operations requiring multiple mass balance calculations.
- Many sites lack sufficient historical data to characterize all streams.

Notwithstanding the complexities presented by real world manufacturing processes, mass balance calculations are essential in organizing data and in identifying material lost to emissions or discharges. Furthermore, by tracking the total mass or specific waste compounds at the unit operation level, the contribution of the unit process to the cost of treating, storing, and disposing of the waste(s) can then be properly assessed.

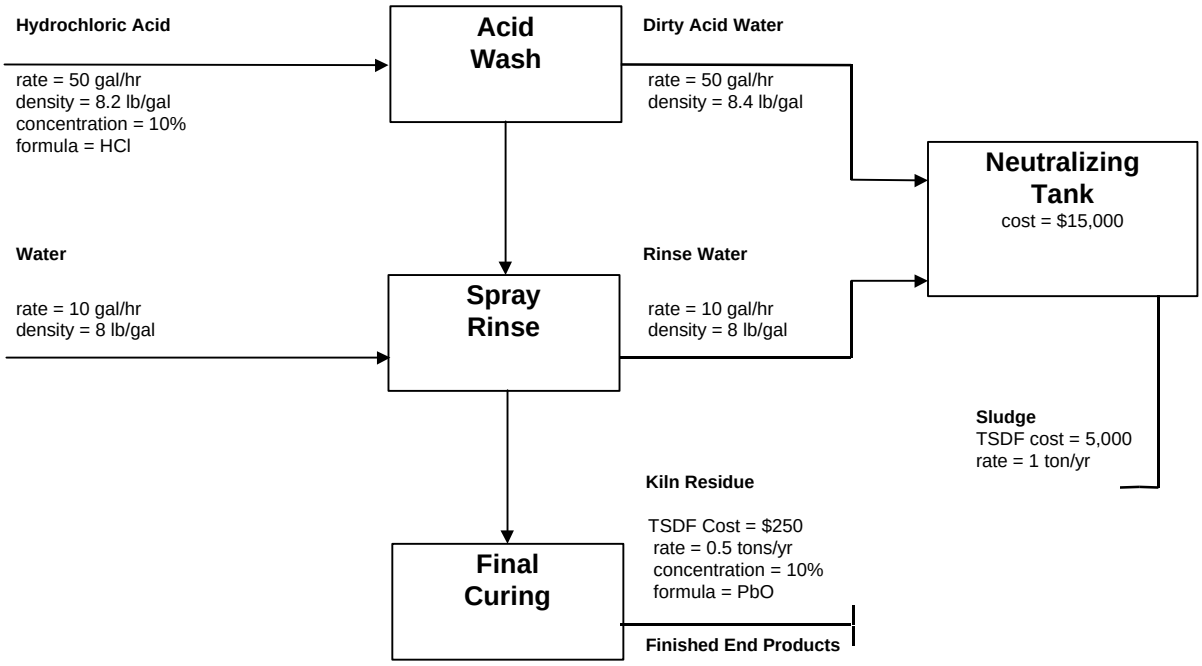
Results of the mass balance calculations are used to generate process flow diagrams for each unit operation or a system of interacting unit operations. A process flow diagram is a visual presentation of the mass or energy entering and leaving the system and is useful for identifying areas of pollution prevention opportunity. Examples of pollution prevention opportunity include:

- Every waste stream leaving an unit operation identifies opportunities to affect that waste stream.
- Every input feed material stream identifies opportunities for substituting alternate feed material and for possible changes in inventory control methodologies.

- Every connection point between unit operations presents opportunities for controlling spillage.
- Every point at which waste streams are joined presents opportunities for waste segregation to enhance recyclability of waste streams.

Presented in Figure 5.1 is an example process diagram.

Figure 5.1 Example Process Diagram



USEPA developed a software tool, the Strategic WAste Minimization Initiative (SWAMI) Version 2.0, that can be used to identify waste minimization opportunities for industrial facilities (EPA/625/11-91/004). The software program provides a scheme for identifying and prioritizing (on a cost or volume basis) waste reduction opportunities in process units and treatment operations, performs mass balance calculations, draws process flow diagrams, and directs the selection of potential waste minimization strategies.

The input data for SWAMI are presented in Tables 5.8 and 5.9 for process and waste treatment system respectively. An example process flow diagram generated by SWAMI is presented in Figure 5.1.

5.3.3 Process and Waste Treatment Data Review and Site Inspection

The mass balance calculations and process diagrams should be reviewed and evaluated to ensure correctness. A thorough and detailed site inspection of the targeted process areas will also need to be conducted to identify operating parameters and other factors that were missing or poorly documented. The site inspection will assist in developing understanding of the manufacturing process and thereby identifying pollution prevention opportunities.

Presented in Table 5.10 are guidelines for preparing and conducting site inspection.

Table 5.10 Site Inspection Guidelines	
Pre-inspection Activities	• Evaluate data complied along with mass balance calculations and process diagrams to gain familiarity with the targeted processes and to identify additional data requirement. • Review existing documents such as operators' manuals and purchasing and shipping records.

Table 5.10 Site Inspection Guidelines	
	• Prepare an inspection agenda that identify the targeted processes and the data requirement. • Schedule the inspection to coincide with operations of targeted processes.
On-site Inspection Activities	• Monitor the process from the point where input materials enter the work-site to the point where products and wastes exit. • Identify all suspected sources of waste. Waste sources to inspect include the production process, piping, maintenance operations, storage areas for raw materials, and finished products. • Monitor the process to identify unmeasured or undocumented releases of wastes. • Interview operators in the targeted process areas to identify operating parameters and waste reduction opportunities. • Evaluate the general conditions of the process equipment. • Examine housekeeping practices throughout the facility. • Check for spillage and leaks. • Check waste storage area for proper waste segregation. • Photograph or videotape the targeted process areas.
Post-inspection Activities	• Update mass balance calculations and process diagrams with new or correct information. • Conduct follow-up site inspections to collect additional data or to clarify questions identified during data analysis.

5.3.4 Identification and Screening of Pollution Prevention Options

The identification and screening of pollution prevention options should follow the sequence of steps presented below:

- Identify Pollution Prevention Options
- Organize Pollution Prevention Options
- Rank Pollution Prevention Options
- Screen Pollution Prevention Options

a. Identify Pollution Prevention Options

Based on the results of the process and waste stream characterization, identify pollution prevention options for the targeted process areas.

In addition to the site-specific information compiled from Detailed Assessment, outside sources of technical information should also be consulted for the development of a comprehensive set of pollution prevention options. These sources of information on pollution prevention techniques include:

- Environmental Canada Code of Practices and BMP Guides
- Federal, provincial, and local environmental agencies
- USEPA and state environmental agencies
- Trade associations
- Published literature

- Equipment vendors
- Consultants
- Other companies.

b. Organize Pollution Prevention Options

The pollution prevention options should be organized in accordance with the environmental management hierarchy presented in Table 3.3.

This organization emphasizes the evaluation and implementation of source reduction pollution prevention options, options such as changes in technology, materials, and products. Other non-pollution prevention waste management options should be assigned lower priorities in evaluation and implementation.

c. Rank Pollution Prevention Options

Within the environmental management hierarchy, the options should be ranked as to the implementation costs. Pollution prevention options that do not require a significant capital expenditure should be evaluated and implemented first.

Examples of these low cost pollution prevention options are:

- Improve operation & maintenance procedures;
- Improve housekeeping practices;
- Improve inventory control; and
- Implement segregation of flows and/or materials.

Proposed pollution prevention options that have high start-up costs will require further detailed study. Some examples of these pollution prevention options are:

- Addition and/or replacement of equipment;
- Process modifications;
- Product reformulation; and
- Material substitutions.

d. Screen Pollution Prevention Options

The pollution prevention options should be screened according to a set of facility-specific criteria to minimize feasibility analysis cost. The screening process will eliminate marginal value or impractical options from further consideration.

The criteria established for prioritizing process areas and waste streams for detailed assessment may be used for screening of pollution prevention options (Table 5.7). Other screening criteria that need to be considered include:

- Waste reduction quantity;
- Potential benefits (e.g., financial, regulatory, liability, workplace safety, etc.);
- Product quality;
- Legal or contractual obligations;
- Production constraints and flexibility;
- Availability and reliability of technology;

- Implementation cost; and
- Regulatory constraints.

The Weighted Sum Method, presented in Section 5.2.4, or a similar method should be used to prioritize complex pollution prevention options.

5.3.5 Feasibility Assessment

The prioritized list of pollution prevention options developed above should be evaluated to determine which are more technically, environmentally, and economically feasible. Rank the feasible options for implementation.

Technical evaluation for complex pollution prevention options, equipment or process related options, may require pilot-scale study to determine applicability and for developing final design. For these types of options, equipment, labor, waste disposal costs should be compiled either based on published data or vendor quotations to be used to determine economic feasibility. Pollution prevention options that were determined to be without technical merits should be eliminated or removed from further consideration.

Technically viable pollution prevention options should be evaluated with respect to a set of environmental criteria. These environmental criteria should be selected to ensure no adverse environmental impacts as a result of implementing the reduction measure. Example environmental criteria include:

- Effect on number and toxicity of waste streams;
- Risk of pollutant transfer to other media;
- Environmental impact of alternate input feed materials;
- Environmental impact of technology changes; and
- Energy consumption.

After consideration of the technical and environmental criteria, economic analysis should be conducted for the selected pollution prevention options. The economic analysis should seek to compare the total costs of the current practice to the total costs of the pollution prevention alternative.

For pollution control activities, regulatory compliance and oversight costs must be included in the analysis. Other regulatory (environmental, health and safety) related costs, that are often allocated to overhead rather directly to the pollution production areas, include report writing, data collection, regulatory research, and permit fees. If these costs are not correctly accounted for, the benefits of pollution prevention can be underestimated.

To ensure complete accounting of all environmental related expenses and intangible costs and benefits, pollution prevention options should be evaluated using the Total Cost Assessment accounting method developed by USEPA. This assessment method modifies the standard accounting system to improve the competitiveness of prevention-oriented investments.

There are four elements of Total Cost Assessment:

- Expanded cost inventory;
- Extended time horizon;

- Use of long-term financial indicators; and
- Direct allocation of costs to processes and products.

Presented in Table 5.11 are costs and other factors that should be considered in using the Total Cost Assessment approach in economic evaluation of pollution prevention options.

Table 5.11 Total Cost Assessment		
Expanded Cost Inventory	**Direct Costs**	Capital Expenditures • Buildings • Equipment and installation • Utility connections • Project engineering Operation and Maintenance Expenses or Revenue • Raw materials • Labor • Waste disposal • Water and energy • Value of recovered material
	Indirect Costs	Administrative Costs Regulatory Compliance Costs • Permitting • Record keeping and reporting • Monitoring Manifesting Insurance Workman's Compensation On-Site Waste Management On-Site Pollution Control Equipment Operation
	Liability Costs	Penalties Fines Personal Injury Property Damage Natural Resources damage Cleanup Costs
	Less-Tangible Benefits	Increased Sales Due to • Improved product quality • Enhanced company image Consumer trust in green products Improved Supplier-Customer relationship Reduced Health maintenance Costs Increased Productivity Due to Improved Employee Relationships Improved Relationships with Regulators
Expanded Time Horizon	Because many of the liability and less-tangible benefits of pollution prevention will occur over a long period of time, therefore economic assessment for pollution prevention projects should be based on a long time frame.	
Long-Term Financial Indicators	The financial indicators should meet the following criteria: • Account for all cash flows during the project • The time value of money Acceptable indicators meeting these criteria include: Net Present Value of an investment, Internal Rate of Return, and Profitability Index.	
Direct Allocation of Costs	Single Pool Concept	Distribute the benefits and costs of pollution prevention across all products and services. A general overhead or administrative cost is included in all transactions.
	Multiple Pool Concept	Distribute the benefits and costs of pollution prevention at the department of other operating unit level.
	Service Center Concept	Distribute the benefits and costs of pollution prevention to only those activities that are directly responsible.

5.3.6 Assessment Report Preparation

The assessment report should contain the results of the facility assessment program including:

- Proposed pollution prevention options;
- Option screening results; and
- Feasibility analysis results.

The proposed pollution prevention options should be prioritized along with recommended implementation schedule. For each proposed pollution prevention option, the report should contain the following information:

- Pollution prevention potential;
- Availability and reliability of technology;
- The overall project economics;
- Implementation cost;
- Estimated time for implementation; and
- Proposed method to measure performance after implantation.

5.4 POLLUTION PREVENTION PROGRESS ASSESSMENT

The objective of pollution prevention progress assessment is to conduct quantitative evaluation of pollutant reduction after implementation of pollution prevention options. The information can be used by plant operators and environmental agencies in evaluating pollution prevention successes and failures and to guide future pollution prevention implementation efforts. The results of the evaluation may also be used to identify new pollution prevention options for this and other facilities.

Pollution reduction can be measures by one or a combination of quantities. These quantities include:

- Quantity of waste treated on-site;
- Quantity of waste shipped off-site;
- Quantity of hazardous materials brought on-site; and
- Reduction in waste toxicity.

Selected quantities for monitoring pollution reduction performance should accurately reflect the waste(s) of interest. Additionally, the quantities should be measurable with the available resources.

For many purposes, it is helpful to normalize the pollutant reduction data in the form of:

$$\frac{\text{pollution quantity}}{\text{economic activity}}$$

Normalization allows the comparison of pollution reduction between different time periods and between similar production facilities. The normalization factor, economic level, can commonly be defined as:

- Total hours the process operated;
- Total employee hours;
- Units of product produced;
- Number of batches processed;
- Units of raw material purchase; and
- Revenue.

For continuous manufacturing processes, the product output or raw material input can be used as indicator of the economic activity level. Flow processes may be measured by volume or weight whereas plating or film-making may be normalized by area. For batch operations, the economic activity level can be related to waste production.

An annual pollution reduction progress report should be prepared to document and track the facility's efforts in pollution prevention. The report should contain information on:

- Progress toward the reduction goals;
- Pollution prevention options implemented;
- Manufacturing process areas affected;
- Changes in production level;
- Quantity of waste reduced/recycled/treated; and
- Problems encountered during implementation of pollution prevention options.

6.0 II PROCEDURES FOR THE DEVELOPMENT OF POLLUTION PREVENTION PLANS

Based on the essential elements of pollution prevention plans presented in Section 5, a step-by-step procedure can be developed for a comprehensive, multi-media pollution prevention plan. For each of the step, worksheets are provided to assist plant operators in preparing pollution prevention plans.

Presented in Table 6.1 is an overview and essential elements of the pollution prevention assessment program.

Table 6.1 Pollution Prevention Plan Development Overview

Step	Task	Task Description
1	Organize Program	• Select team members to develop pollution prevention plan • Develop pollution prevention/reduction goals
2	Background Information	• Develop industrial profile
3	Environmental Review	• Compile plant data • Conduct site inspection • Identify potential pollution prevention areas • Prioritize potential pollution prevention areas
4	Detailed Assessment	• Collect data for targeted areas identified in environmental review • Organize and document process and waste stream data • Review process and waste treatment data and conduct detailed site inspection • Identify and screen pollution prevention options • Conduct feasibility assessments • Prepare and review the assessment report
5	**Write Pollution Prevention Plan**	• **Write the facility Pollution Prevention Plan**
6	Implement Pollution Prevention Plan	• Implement pollution prevention options
7	Measuring Pollution Reduction Progress	• Monitor pollution prevention progress

Steps 1 to 4 are essential elements for developing pollution prevention plans. Step 5 is the writing of the Pollution Prevention Plan. Steps 6 and 7 are elements for implementing the plan and measuring pollution reduction progress.

6.1 STEP 1 - ORGANIZE PROGRAM

Task 1.1: Select Team Members to Develop Pollution Prevention Plan

Select team members for the development of the pollution prevention plan. The study team members should have substantial technical, business, and communication skills as well as thorough knowledge of the company.

The areas of expertise to consider include:

- Management
- Engineering
- Quality control
- Production and maintenance
- Accounting and purchasing
- Legal
- Health and safety
- Research and development
- Environmental.

Task 1.2: Develop Pollution Prevention/Reduction Goals

Identify the scope and objectives/goals of the pollution prevention plan. The goals serve to focus effort and build consensus. The goal should be:

- well-defined
- meaningful to all employees
- challenging and achievable
- flexible and adaptable.

Output:	**Long-term Direction and Goals for the Pollution Prevention Program**

6.2 STEP 2 - BACKGROUND INFORMATION

Task 2: Develop Industrial Profile

Review published literature to develop background information on the manufacturing process, industrial activity, and waste generation/waste management methods, and BMPs practiced by similar production facilities.

The industry background information can be compiled from Codes of Practice/Best Management Practices Guides, discharge/emission monitoring reports, USEPA effluent limitations development documents and guides to pollution prevention.

Output: An Industry Profile of the Industrial Sector Under Consideration

Reference: Section 5.1 Industrial Profile

6.3 STEP 3 - ENVIRONMENTAL REVIEW

Task 3.1: Compile Plant data

Collect facility-specific data. The data collection requirements are outlined in Section 5.2.1, Table 5.5. The required data categories include:

- Raw Materials
- Process Description
- Products
- Waste Materials
- Waste Management Methods
- Environmental Permit Requirements

For this environmental review, compile these data from existing sources. Reserve any extensive and costly data collection programs for detailed assessment. Examples of existing and readily available data sources are presented in Section 5.2.1, Table 5.6.

The following worksheets, (1 to 5) will assist in identifying the data requirements and in organizing the compiled data. These worksheets are intentionally generic and will need customization for specific industrial sectors and facilities. In addition to customization, develop facility-specific worksheets as required.

Use the site-specific data and prepare mass balances for waste components of concerns and plant flow diagrams showing the types and quantities of all raw materials entering and all products and wastes leaving the plant.

Output:	**Completed Data Worksheets** **Waste Materials Mass Balances** **Plant Flow Diagrams**

Task 3.2: Conduct Site Inspection

Conduct a site inspection to review the results of the data collection program. Using data collected during the site inspection, update the mass balances and plant flow diagrams.

Output: Updated Worksheets, Mass Balances, and Plant Flow Diagrams

Task 3.3: Identify Potential Pollution Prevention Areas

Develop facility-specific criteria for identifying and selecting potential process areas and waste streams for further evaluation of potential pollution prevention opportunities. Typically, production areas, raw materials, or waste materials that incur high manufacturing cost, generate high waste volume, or high disposal cost are targeted as potential areas for detailed study.

Presented in Section 5.2.3, Table 5.7 are some of the criteria that need to be consider when selecting potential pollution prevention areas. Typical criteria for prioritizing waste stream for further study include:

- Compliance with current and anticipated environmental regulations
- Impacts to environment
- Impacts to public health
- Potential environmental and safety liability
- Quantity of waste
- Hazardous properties of the waste
- Potential for pollution prevention
- Costs of waste management
- Reducing energy use.

Output: A List of Potential Pollution Prevention Areas

Task 3.4: Prioritize Potential Pollution Prevention Areas

Prioritize the list of potential pollution prevention areas identified in Task 3.3. Use the Weighted Sum Method or a similar quantitative method to rank the identified potential process areas and waste streams. The Weighted Sum Method is described in Section 5.2.4.

For ranking potential pollution prevention areas, use the facility-specific selection criteria developed in Task 3.3.

Output: A Prioritized List of Potential Pollution Prevention Areas

Reference: Section 5.2 Environmental Review

Pollution Prevention Assessment Worksheets **Worksheet 1** **Facility Information**	
Prepared by:	Date:
General Facility Information	
Parent Organization Name: Address: City: Province/Postal Code: Telephone: Lead Person:	Subject Facility Name: Address: City: Province/Postal Code: Telephone: Lead Person:
Facility Production Information	
SIC Code(s) (post PRIMARY in No. 1) 1. 2. 3. 4. Product or Service: Production or Service Level(s) (previous calendar year): Schedule of Operation: Seasonal Operating Schedule:	
Regulatory Information (check all that apply)	
• Liquid (Effluent) Waste Permit • Air Permit • Solid Waste Permit • Special Waste Permit • Other (please list)	Permit No. Permit No. Permit No. Permit No. Permit No.

Pollution Prevention Assessment Worksheets			
Worksheet 2			**Process Information**
Prepared by:	Date:		
Process Unit/Operation: Operation Type: • Continuous • Batch/Semi-Batch • Discrete • Other			
Document	Status		
	Complete? (Y/N)	Current? (Y/N)	Document No.
Process Flow Diagram			
Material/Energy Balance			
Design			
Actual			
Flow/Amount Measurements			
Input Stream(s)			
Product Stream(s)			
Waste Stream(s)			
Analytical Data			
Input Stream(s)			
Product Stream(S)			
Waste Stream(s)			
Operating Schedules			
Labor Usage/Cost			
Operation & Maintenance Cost			
Energy Usage/Cost			
Process Description			
Operating Manuals			
Equipment List/Specification			
Piping/Instrument Diagrams			
Plot/Elevation Plan(s)			
Work Flow Diagrams			
Hazardous Waste Manifests			
Emission Inventories			
Environmental Audit Reports			
Material Safety Data Sheets			
Product Inventory Records			
Raw Material Inventory Records			
Operator Data Logs			

Pollution Prevention Assessment Worksheets		
Worksheet 3		**Input Material Information**
Prepared by:	Date:	
Process Unit/Operation: Operation Type:		

• Continuous	• Batch/Semi-Batch
• Discrete	• Other

Attribute	Description		
	Input Stream No. 1	Input Stream No. 2	Input Stream No. 3
Material Name/Description			
Source/Supplier			
Active Ingredients or Component of Concern			
Hazardous Properties			
Media (Gas, Liquid, Solids)			
Usage Rate			
Unit Cost			
Delivery Mode: (e.g., Trucks, Rail Cars, Ship, pipeline, etc.)			
Shipping Container Size & Type: (e.g., 55 gal drum, 100 lb paper bag, etc.)			
Unloading Method: (e.g., pump, forklift, conveyor, etc.)			
Storage Location: (Outdoor, Covered, Underground, etc.)			
Empty Container Disposal Method: (e.g., Return to Supplier, landfill, recycle, etc.)			
Shelf Life			
Supplier Would • accept expired material? • accept shipping containers? • revise expiration date?			
Alternate Feed Material			
Alternate Supplier(s)			

Pollution Prevention Assessment Worksheets **Worksheet 4** **Product Output Information**			
Prepared by: Date:			
Process Unit/Operation: Operation Type: • Continuous • Batch/Semi-Batch • Discrete • Other			
Attribute	Description		
	Product Stream No. 1	Product Stream No. 2	Product Stream No. 3
Material Name/Description			
Active Ingredients or Component of Concern			
Hazardous Properties			
Media (Gas, Liquid, Solids)			
Production Rate			
Revenues			
Shipping Mode: (e.g., Trucks, Rail Cars, Ship, pipeline, etc.)			
Shipping Container Size & Type: (e.g., 55 gal drum, 100 lb paper bag, etc.)			
Loading Method: (e.g., pump, forklift, conveyor, etc.)			
Storage Location: (Outdoor, Covered, Underground, etc.)			
Shipping Containers Returnable?			
Shelf Life			
Product Reformulation?			
Customer Would • accept changes in specifications? • accept larger shipping containers?			

Pollution Prevention Assessment Worksheets **Worksheet 5** **Waste Material Information**			
Prepared by: Date:			
Process Unit/Operation: Operation Type: • Continuous • Batch/Semi-Batch • Discrete • Other			
Attribute	Description		
	Waste Stream No. 1	Waste Stream No. 2	Waste Stream No. 3
Material Name/Description			
Active Ingredients or Component of Concern			
Hazardous Properties			
Media (Gas, Liquid, Solids)			
Regulated Material(s)			
Generation Rate			
Fate of Waste Material(s): (e.g., off-site disposal, on-site treatment, blending, recycle, etc.)			
Waste Management Cost			
Waste Shipping Mode: (e.g., Trucks, Rail Cars, Ship, pipeline, etc.)			
Waste Shipping Container Size & Type: (e.g., 55 gal drum, tank car, etc.)			
Loading Method: (e.g., pump, forklift, conveyor, etc.)			
Storage Location: (Outdoor, Covered, Underground, etc.)			

6.4 STEP 4 - DETAILED ASSESSMENT

Task 4.1: Collect Data for Targeted Areas Identified in Environmental Review

Use a multi-media approach, which encompasses air, water, and solid waste to quantify the total waste loads discharged from each targeted process area.

Use the following worksheets (2 to 5) to collect facility-specific information. These worksheets are intentionally generic and will need customization for specific industrial sectors and facilities. In addition to customization, develop facility-specific worksheets as required.

Use Tables 5.8 and 5.9 in Section 5.3 to collect and organize process and waste treatment system information.

The tables organize the data into:

- Manufacturing Process/Unit Operation
- Input Feed material
- Waste Streams
- Product.

These data will be used to generate mass balances and process flow diagrams.

Output: Completed Data Worksheets

Task 4.2: Organize and Document Process and Waste Treatment Data

Use the compiled data and prepare mass balances for waste components of concern. Calculate a material balance for each waste component of concern for each targeted unit operation or an entire process.

The USEPA's *Strategic Waste Minimization Initiative (SWAMI) Version 2.0*, a software tool can be used to perform mass balance calculations, draw process flow diagrams, and direct the selection of potential waste minimization strategies.

Output: Waste Materials Mass Balances
Unit Process/Waste Treatment Flow Diagrams

Task 4.3: Review Process and Waste Treatment Data and Conduct Detailed Site Inspection

Review and evaluate the mass balance calculations and process flow diagrams to ensure correctness.

Conduct a through and detailed site inspection of the targeted process areas to identify operating parameters and other factors that were missed or poorly documented.

Use the Site Inspection Guidelines presented in Table 5.10, Section 5.3.3 to prepare and to conduct the site inspection.

Output: Updated Waste Materials Mass Balances
Updated Unit Process/Waste Treatment Flow Diagrams

Task 4.4: Identify and Screen Pollution Prevention Options

a. Identify Pollution Prevention Options

Review outside technical information sources to identify industrial sector-specific pollution prevention measures. These sources include:

- Environmental Canada codes of practice and BMP guides
- Federal, provincial, and local environmental agencies
- USEPA and state environmental agencies
- Trade associations
- Published literature
- Equipment vendors
- Consultants
- Other companies

Use the results of Task 4.3 and review from outside technical information sources, identify pollution prevention measures.

b. Organize Pollution Prevention Options

Organize the pollution prevention options in the following order.

1. Source reduction
2. On-site reuse and recycling
3. Off-site reuse and recycling
4. Material and/or energy recovery
5. Residual waste management

This environmental management hierarchy is presented in Table 3.3, Section 3.3.

Use Worksheet 6 to organize the pollution prevention options.

c. Rank Pollution Prevention Options

Rank the pollution prevention options, organized in accordance with the environmental management hierarchy, with respect to the implementation costs. Implement pollution prevention options that do not require significant capital expenditures.

Low cost pollution prevention options are usually BMPs. Examples of these low cost options are:

- Improve operation & maintenance procedures
- Improve housekeeping practices
- Improve inventory control
- Implement flow/material segregation

d. Screen Pollution Prevention Options

Use the Weighted Sum Method, presented in Section 5.2.4, or similar method for prioritizing the pollution prevention options identified above.

Use the facility-specific selection criteria, developed in Task 3.3 of Environmental Review, to rank pollution prevention options.

Output:	**A Listing of Prioritized Potential Prevention Options for the Targeted Areas**

Task 4.5: Conduct Feasibility Assessments

Evaluate the prioritized listing of pollution prevention options to determine which options are technically, environmentally, and economically feasible.

a. Technical Evaluation

Use published data or vendor quotations to determine pollution prevention economic feasibility.

Perform pilot-scale study for complex pollution prevention options.

b. Environmental Evaluation

Evaluate technically viable options with respect to a set of environmental criteria. Example environmental criteria are:

- Effect on number and toxicity of waste streams
- Risk of pollution transfer to other media
- Environmental impact of alternate input feed materials
- Environmental impact of technology changes
- Energy consumption.

c. Economic Evaluation

Use Total Cost Assessment or similar accounting method to determine pollution prevention option economic viability.

The Total Cost Assessment method is described in Section 5.3.5.

Output:	**A Listing of Technically, Environmentally, and Economically, Feasible Potential Prevention Options for the Targeted Areas**

Task 4.6: Prepare and Review the Assessment Report

Prepare a report containing the results of the Detailed Assessment Program. This report should include:

- Proposed pollution prevention options;
- Option screening results; and
- Feasibility analysis results.

Output: Detailed Assessment Program Report

Reference: Section 5.3 Detailed Assessment

Pollution Prevention Assessment Worksheets	
Worksheet 6	**Pollution Prevention Option**
Prepared by:	Date:
Pollution Prevention Option Name: Description:	
Unit Process/Operation Affected:	
Waste Stream(s) Affected:	
Input Material(s) Affected:	
Product(s) Affected:	
Pollution Prevention Option Category	
Best Management Practices Input Material Changes	Product Changes Technology/Process Changes
Recycling/Reuse	
On-Site	Off-Site

6.5 STEP 5 - WRITE POLLUTION PREVENTION PLAN

Task 5: Write the Facility Pollution Prevention Plan

The facility pollution prevention plan will include part or all of the following elements:

- A written policy articulating management and corporate support for the pollution prevention plan and a commitment to implement planned activities and achieve established goals.

- The scope and objectives of the pollution prevention plan. Scope includes the facilities, or processes that the plan will cover.

- A description of the facility including:

Manufacturing processes;
Products and/or services;
Production levels; and
Regulatory permits.

- An industry profile characterizing the various operations within the industrial sector under consideration.

- A plan to perform an environmental review or a summary of review results, including:

The types and quantities of all raw materials entering and all products and wastes leaving the plant;
The treatment and disposal of the wastes in all media;
Current and past pollution prevention activities; and
Prioritized waste streams or process areas for detailed assessment.

- A plan to perform a detailed assessment or a summary of assessment results, including:
  Facility-specific criteria for prioritizing candidate processes and waste streams for pollution prevention projects;
  Criteria for prioritizing pollution prevention options; and
  Prioritized listing of feasible pollution prevention options.

- A selection of pollution prevention options to be implemented. For each selected options, the process(es) it affects should be identified, and estimates of the amount of the reduction of the wastes.

- A five year implementation schedule which presents the planned pollution prevention implementation activities for each of the five calendar years following the completion of the pollution prevention plan.

Presented in the following is an example pollution prevention plan format.

Pollution Prevention Plan

(1) <u>Facility Identification</u>

Facility Name: _____

Management Policy:

Write a management policy expressing support for planning and a commitment to implement planned activities and achieve established goals.

Scope and Objectives:
Identify the facilities and/or processes to be covered by the plan. State the objectives to be achieved through planning and implementation.

Management Signature:
The owner, chief executive officer, or other person with the authority to commit management to the plan must sign the plan.

Prepared by: **Date:**

Pollution Prevention Plan

(2) Facility Profile:

Write facility profile containing information on:

- Manufacturing processes;
- Products and/or services;
- Production levels; and
- Regulatory permits.

General Facility Information	
Parent Organization Name: Address: City: Province/Postal Code: Telephone: Lead Person:	Subject Facility Name: Address: City: Province/Postal Code: Telephone: Lead Person:
Facility Production Information	
SIC Code(s) (post PRIMARY in No. 1) 1. 2. 3. 4. Manufacturing Processes: Product or Service: Production or Service Level(s) (previous calendar year): Schedule of Operation: Seasonal Operating Schedule:	
Regulatory Information	
• Liquid (Effluent) Waste Permit • Air Permit • Solid Waste Permit • Special Waste Permit • Other (please list)	Permit No. Permit No. Permit No. Permit No. Permit No.

Pollution Prevention Plan

(3) Industry Profile:

Write an industry profile describing the various industries within the industrial sector under consideration. The industry profile should contain information on:

- Industry Description
- Raw Materials (including active agents)
- Process Description
- Products/Services
- Waste Materials
- Waste Management Methods
- Environmental Permit Requirements and Performance

Drawings and flow diagrams that describe the industry and manufacturing processes should be included in the industry profile.

Pollution Prevention Plan

(4) Summary of the Environmental Review:

1. List each Raw Material which contain hazardous substances or active agents of concern.

Raw Material	Amount Used	Hazardous Substances or Active Agents	Amount of Hazardous Substances or Active Agents	Process(es) Where Used

2. List each Product which contain hazardous substances or active agents of concern.

Product	Amount Produced	Hazardous Substances or Active Agents	Amount of Hazardous Substances or Active Agents	Process(es) Where Produced

3. List each Waste Material which contain hazardous substances or active agents of concern.

Waste Material	Amount Produced	Hazardous Substances or Active Agents	Amount of Hazardous Substances or Active Agents	Generating Process(es)

Waste Material	Amount Produced	Hazardous Substances or Active Agents	Amount of Hazardous Substances or Active Agents	Generating Process(es)

Current and Past Pollution Prevention Activities:
Describe any reduction, recycling, BMPs, and treatment activities currently underway at the facility.

Describe any hazardous substance use or hazardous waste reduction activities already completed. If possible, estimate the reductions achieved and the implementation cost and any cost saving achieved.

Prioritized Waste Streams or Process Areas for Detailed Assessment:
List the potential areas identified for further detailed assessment. categorized

Pollution Prevention Plan

(5) Summary of the Detailed Assessment:

1. List the facility-specific criteria for prioritizing candidate processes and waste streams for pollution prevention projects.

2. List the facility-specific criteria for prioritizing pollution prevention options.

3. List the prioritized feasible pollution prevention options.

Option Category	Ranking	Pollution Prevention Options	Process Affected	Media (air, water, solids)
Source Reduction	**1**			
	2			
	3			
	4			
	5			
	6			
On-site Reuse				
Off-site Reuse				
Material and/or Energy Recovery				
Residual Waste Management				

Pollution Prevention Plan

(6) Proposed Pollution Prevention Options:

List the proposed prioritized feasible pollution prevention options. For each option, the process(es) it affects should be identified, and estimates of the amount of the reduction in wastes.

Option Category	Process Affected	Pollution Prevention Options	Media (air, water, solids)	Waste Reduction
Source Reduction				
On-site Reuse				
Off-site Reuse				
Material and/or Energy Recovery				
Residual Waste Management				

Pollution Prevention Plan

(7) Five-Year Pollution Prevention Implementation Plan:

1. Develop a schedule for implementing the reduction options selected. Indicate when, in the next five years, the options or phases of options will be implemented. Provide an expected completion date if implementation will take longer than five year.

Pollution Prevention Options	Estimated Implementation Date (month/year)					
	Year 1	Year 2	Year 3	Year 4	Year 5	Later

2. Provide estimates of the total costs and benefits to be realized from implementing the selected pollution prevention options over the five year life of the plan.

Pollution Prevention Options	Estimated Total Costs and Benefits (costs/savings)					
	Year 1	Year 2	Year 3	Year 4	Year 5	Later

6.6 STEP 6 - IMPLEMENT POLLUTION PREVENTION PLAN

Task: Implement Pollution Prevention Plan

Implement pollution prevention options that do not require significant capital expenditures.

Obtain funding for pollution prevention projects that require capital expenditures.

Output: Selected Pollution Prevention Options In-Placed

6.7 STEP 7 - MEASURING POLLUTION REDUCTION PROGRESS

Task: Monitor Pollution Prevention Progress

Collect data to quantify the pollution reduction progress. Examples waste reduction monitoring parameters are:

- Quantity of waste treated on-site
- Quantity of waste shipped off-site
- Quantity of hazardous materials brought on-site
- Reduction on waste toxicity.

Normalize the pollution reduction data to the economic level. Define the plant's economic level as:

- Total hours the process operated
- Total employee hours
- Units of products produced
- Number of batches processed
- Units of raw material purchased
- Revenue.

Prepare an annual pollution reduction progress report to document and track the facility's efforts. The report should contain information on:

- Progress toward the reduction goals
- Pollution prevention options implemented
- Manufacturing process areas affected
- Changes in production level
- Quantity of waste reduced/recycled/treated
- Problems encountered during implementation of pollution prevention options.

Use Worksheet 7 to organize the pollution reduction data for reporting.

Output: An Annual Pollution Reduction Progress Report

Reference: Section 5.4 Pollution Prevention Progress Assessment

Pollution Prevention Assessment Worksheets			
Worksheet 2			**Process Information**
Prepared by:	Date:		
Process Unit/Operation: Operation Type: • Continuous • Batch/Semi-Batch • Discrete • Other			
Document	Status		
	Complete? (Y/N)	Current? (Y/N)	Document No.
Process Flow Diagram			
Material/Energy Balance			
Design			
Actual			
Flow/Amount Measurements			
Input Stream(s)			
Product Stream(s)			
Waste Stream(s)			
Analytical Data			
Input Stream(s)			
Product Stream(S)			
Waste Stream(s)			
Operating Schedules			
Labor Usage/Cost			
Operation & Maintenance Cost			
Energy Usage/Cost			
Process Description			
Operating Manuals			
Equipment List/Specification			
Piping/Instrument Diagrams			
Plot/Elevation Plan(s)			
Work Flow Diagrams			
Hazardous Waste Manifests			
Emission Inventories			
Environmental Audit Reports			
Material Safety Data Sheets			
Product Inventory Records			
Raw Material Inventory Records			
Operator Data Logs			

Pollution Prevention Assessment Worksheets		
Worksheet 3		**Input Material Information**
Prepared by:	Date:	
Process Unit/Operation: Operation Type:		

• Continuous	• Batch/Semi-Batch
• Discrete	• Other

Attribute	Description		
	Input Stream No. 1	Input Stream No. 2	Input Stream No. 3
Material Name/Description			
Source/Supplier			
Active Ingredients or Component of Concern			
Hazardous Properties			
Media (Gas, Liquid, Solids)			
Usage Rate			
Unit Cost			
Delivery Mode: (e.g., Trucks, Rail Cars, Ship, pipeline, etc.)			
Shipping Container Size & Type: (e.g., 55 gal drum, 100 lb paper bag, etc.)			
Unloading Method: (e.g., pump, forklift, conveyor, etc.)			
Storage Location: (Outdoor, Covered, Underground, etc.)			
Empty Container Disposal Method: (e.g., Return to Supplier, landfill, recycle, etc.)			
Shelf Life			
Supplier Would • accept expired material? • accept shipping containers? • revise expiration date?			
Alternate Feed Material			
Alternate Supplier(s)			

Pollution Prevention Assessment Worksheets **Worksheet 4** **Product Output Information**			
Prepared by: Date:			
Process Unit/Operation: Operation Type: • Continuous • Batch/Semi-Batch • Discrete • Other			
Attribute	Description		
	Product Stream No. 1	Product Stream No. 2	Product Stream No. 3
Material Name/Description			
Active Ingredients or Component of Concern			
Hazardous Properties			
Media (Gas, Liquid, Solids)			
Production Rate			
Revenues			
Shipping Mode: (e.g., Trucks, Rail Cars, Ship, pipeline, etc.)			
Shipping Container Size & Type: (e.g., 55 gal drum, 100 lb paper bag, etc.)			
Loading Method: (e.g., pump, forklift, conveyor, etc.)			
Storage Location: (Outdoor, Covered, Underground, etc.)			
Shipping Containers Returnable?			
Shelf Life			
Product Reformulation?			
Customer Would • accept changes in specifications? • accept larger shipping containers?			

Pollution Prevention Assessment Worksheets **Worksheet 5** **Waste Material Information**			
Prepared by: Date:			
Process Unit/Operation: Operation Type: • Continuous • Batch/Semi-Batch • Discrete • Other			
Attribute	Description		
	Waste Stream No. 1	Waste Stream No. 2	Waste Stream No. 3
Material Name/Description			
Active Ingredients or Component of Concern			
Hazardous Properties			
Media (Gas, Liquid, Solids)			
Regulated Material(s)			
Generation Rate			
Fate of Waste Material(s): (e.g., off-site disposal, on-site treatment, blending, recycle, etc.)			
Waste Management Cost			
Waste Shipping Mode: (e.g., Trucks, Rail Cars, Ship, pipeline, etc.)			
Waste Shipping Container Size & Type: (e.g., 55 gal drum, tank car, etc.)			
Loading Method: (e.g., pump, forklift, conveyor, etc.)			
Storage Location: (Outdoor, Covered, Underground, etc.)			

Pollution Prevention Assessment Worksheets **Worksheet 6** **Pollution Prevention Option**	
Prepared by:	Date:
Pollution Prevention Option Name: Description:	
Unit Process/Operation Affected:	
Waste Stream(s) Affected:	
Input Material(s) Affected:	
Product(s) Affected:	
Pollution Prevention Option Category • Best Management Practices • Input Material Changes	• Product Changes • Technology/Process Changes
Recycling/Reuse • On-Site	• Off-Site

Pollution Prevention Assessment Worksheets **Worksheet 7**				**Pollution Reduction Measurement**
Prepared by:		Date:		
Subject Facility:		Reporting Period:		
Wastes Affected	Pollution Prevention Options			Actual Reductions**
	Option Name	Option Category*	Unit Process Affected	

Economic Level/Normalization Factor (examples)

Total hours process operated: Number of batches processed:
Total employee hours: Units of raw material purchased:
Units of product produced: Revenue:

*Pollution Prevention Option Category

- Best Management Practices
- Input Material Changes
- Product Changes
- Technology/Process Changes

** Report actual reduction, not normalized for economic level

Problems Encountered (including steps taken or proposed to resolve the problems):

7.0 II SELECTED BIBLIOGRAPHY

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Appendix

Samples of Worksheets

Pollution Prevention Assessment Worksheets **Worksheet 1** **Facility Information**	
Prepared by:	Date:
General Facility Information	
Parent Organization Name: Address: City: Province/Postal Code: Telephone: Lead Person:	Subject Facility Name: Address: City: Province/Postal Code: Telephone: Lead Person:
Facility Production Information	
SIC Code(s) (post PRIMARY in No. 1) 1. 2. 3. 4. Product or Service: Production or Service Level(s) (previous calendar year): Schedule of Operation: Seasonal Operating Schedule:	
Regulatory Information (check all that apply)	
Waste Permit	Permit No.
Air Permit	Permit No.
Solid Waste Permit	Permit No.
Special Waste Permit	Permit No.
Other (please list)	Permit No.

Pollution Prevention Assessment Worksheets **Worksheet 2** **Process Information**			
Prepared by:	Date:		
Process Unit/Operation: Operation Type: Continuous Batch/Semi-Batch Discrete Other			
Document	Status		
	Complete? (Y/N)	Current? (Y/N)	Document No.
Process Flow Diagram			
Material/Energy Balance			
Design			
Actual			
Flow/Amount Measurements			
Input Stream(s)			
Product Stream(s)			
Waste Stream(s)			
Analytical Data			
Input Stream(s)			
Product Stream(S)			
Waste Stream(s)			
Operating Schedules			
Labor Usage/Cost			
Operation & Maintenance Cost			
Energy Usage/Cost			
Process Description			
Operating Manuals			
Equipment List/Specification			
Piping/Instrument Diagrams			
Plot/Elevation Plan(s)			
Work Flow Diagrams			
Hazardous Waste Manifests			
Emission Inventories			
Environmental Audit Reports			
Material Safety Data Sheets			
Product Inventory Records			
Raw Material Inventory Records			
Operator Data Logs			

Pollution Prevention Assessment Worksheets **Worksheet 3** **Input Material Information**			
Prepared by:	Date:		
Process Unit/Operation: Operation Type: Continuous Batch/Semi-Batch Discrete Other			
Attribute	Description		
	Input Stream No. 1	Input Stream No. 2	Input Stream No. 3
Material Name/Description			
Source/Supplier			
Active Ingredients or Component of Concern			
Hazardous Properties			
Media (Gas, Liquid, Solids)			
Usage Rate			
Unit Cost			
Delivery Mode: (e.g., Trucks, Rail Cars, Ship, pipeline, etc.)			
Shipping Container Size & Type: (e.g., 55 gal drum, 100 lb paper bag, etc.)			
Unloading Method: (e.g., pump, forklift, conveyor, etc.)			
Storage Location: (Outdoor, Covered, Underground, etc.)			
Empty Container Disposal Method: (e.g., Return to Supplier, landfill, recycle, etc.)			
Shelf Life			
Supplier Would • accept expired material? • accept shipping containers? • revise expiration date?			
Alternate Feed Material			
Alternate Supplier(s)			

Pollution Prevention Assessment Worksheets **Worksheet 4** **Product Output Information**			
Prepared by:	Date:		
Process Unit/Operation: Operation Type: Continuous Batch/Semi-Batch Discrete Other			
Attribute	Description		
	Product Stream No. 1	Product Stream No. 2	Product Stream No. 3
Material Name/Description			
Active Ingredients or Component of Concern			
Hazardous Properties			
Media (Gas, Liquid, Solids)			
Production Rate			
Revenues			
Shipping Mode: (e.g., Trucks, Rail Cars, Ship, pipeline, etc.)			
Shipping Container Size & Type: (e.g., 55 gal drum, 100 lb paper bag, etc.)			
Loading Method: (e.g., pump, forklift, conveyor, etc.)			
Storage Location: (Outdoor, Covered, Underground, etc.)			
Shipping Containers Returnable?			
Shelf Life			
Product Reformulation?			
Customer Would • accept changes in specifications? • accept larger shipping containers?			

Pollution Prevention Assessment Worksheets **Worksheet 5** **Waste Material Information**			
Prepared by: Date:			
Process Unit/Operation: Operation Type: Continuous Batch/Semi-Batch Discrete Other			
Attribute	Description		
	Waste Stream No. 1	Waste Stream No. 2	Waste Stream No. 3
Material Name/Description			
Active Ingredients or Component of Concern			
Hazardous Properties			
Media (Gas, Liquid, Solids)			
Regulated Material(s)			
Generation Rate			
Fate of Waste Material(s): (e.g., off-site disposal, on-site treatment, blending, recycle, etc.)			
Waste Management Cost			
Waste Shipping Mode: (e.g., Trucks, Rail Cars, Ship, pipeline, etc.)			
Waste Shipping Container Size & Type: (e.g., 55 gal drum, tank car, etc.)			
Loading Method: (e.g., pump, forklift, conveyor, etc.)			
Storage Location: (Outdoor, Covered, Underground, etc.)			

Pollution Prevention Assessment Worksheets **Worksheet 6** **Pollution Prevention Option**	
Prepared by:	Date:
Pollution Prevention Option Name: Description:	
Unit Process/Operation Affected:	
Waste Stream(s) Affected:	
Input Material(s) Affected:	
Product(s) Affected:	
Pollution Prevention Option Category Best Management Practices Input Material Changes	 Product Changes Technology/Process Changes
Recycling/Reuse On-Site	 Off-Site

Pollution Prevention Assessment Worksheets

Worksheet 7 **Pollution Reduction Measurement**

Prepared by: Date:

Subject Facility: Reporting Period:

Wastes Affected	Pollution Prevention Options			Actual Reductions**
	Option Name	Option Category*	Unit Process Affected	

Economic Level/Normalization Factor (examples)

Total hours process operated: Number of batches processed:
Total employee hours: Units of raw material purchased:
Units of product produced: Revenue:

*Pollution Prevention Option Category

Best Management Practices Product Changes
Input Material Changes Technology/Process Changes

** Report actual reduction, not normalized for economic level

Problems Encountered (including steps taken or proposed to resolve the problems):