FRASER RIVER
ACTION PLAN

Technical Pollution Prevention Guide for the Fruit and Vegetable Processing Industry in the Lower Fraser Basin

DOE FRAP 1996-18

Environment Canada Environnement Canada

TECHNICAL POLLUTION PREVENTION GUIDE FOR THE FRUIT AND VEGETABLE PROCESSING INDUSTRY IN THE LOWER FRASER BASIN

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Prepared for:

Environment Canada
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DISCLAIMER

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ABSTRACT

The guide gives a brief description of the fruit and vegetable processing industry and identifies environmental issues unique to this industry. It then provides a study methodology to enable plant operators to carry out a disinterested internal review of possible sources of pollution within their own facilities. Lastly, the document offers suggestions to the industry for the development of pollution prevention programmes.

The industry profile covers only processing plants which receive fresh vegetables or berries from the field and wash them before freezing or canning. It does not deal with secondary processors manufacturing soups or jams.

Preparation of this guide was financed by the Fraser Pollution Abatement Office of Environment Canada.

SOMMAIRE

Le guide décrit brièvement l'industrie de transformation de fruits et légumes en identifiant les problèmes relatifs à l'environnement qui sont particuliers à cette industrie. Il offre ensuite un protocole d'étude apte à permettre aux opérateurs d'usine de procéder à l'auto-examen désintéressé des sources éventuelles de pollution au sein de leurs propres installations. Enfin, le document propose à l'industrie des suggestions pour l'élaboration de programmes de prévention de la pollution.

Le sommaire de l'industrie porte uniquement sur les installations de traitement qui reçoivent des légumes ou baies fraîches des champs et les lavent avant la congélation ou la mise en boîte. Il ne traite pas des industries secondaires de transformation en soupes ou en confitures.

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TECHNICAL POLLUTION PREVENTION GUIDE

FOR THE FRUIT AND VEGETABLE PROCESSING INDUSTRY IN THE LOWER FRASER BASIN

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GLOSSARY OF ABBREVIATIONS

AAFC	Agriculture and Agri-Food Canada
BAT	Best Available Technology. Systems and equipment applied at any point in the process to prevent pollution.
BCMAFF	BC Ministry of Agriculture, Food and Fisheries
BCMOELP	BC Ministry of Environment, Lands and Parks
BMP	Best Management Practice. Generally refers to pollution prevention practices in the plant.
BOD	(Also BOD_5 which is BOD at five days [120 hours] after commencement of laboratory test.) Biochemical Oxygen Demand. A parameter that is a measure of the pollution potential or strength of a wastewater. This is a measure of the organic load in the waste that will support the growth of micro-organisms which consume oxygen to sustain their metabolism.
CFC	Chloro-fluorocarbon. A family of refrigerants; commonly Freon (R11, R12) which has high ozone depletion potential.
COD	Chemical Oxygen Demand or oxygen consumed-dichromate. A pollution strength parameter or test that is a measure of the contaminant load in wastewater that depletes oxygen.
CSA	Canadian Standards Association
DAF	Dissolved Air Floatation. An effluent treatment technology that relies on chemical flocculants and dissolved air entrainment to create flocs that can be physically separated from the effluent.
DFO	Department of Fisheries and Oceans. A Canadian federal government department with jurisdiction over anodromous fish bearing receiving waters.
EPA	(Also USEPA.) United States Environmental Protection Agency. A federal agency.
EPS	Environmental Protection Service. A department of Environment Canada, a federal government agency.
GRAAP	Generally Regarded As Acceptable Practice
GRAS	Generally Regarded As Safe
GRAUP	Generally Regarded As Unacceptable Practice
GVRD	Greater Vancouver Regional District
GVS&DD	Greater Vancouver Sewage and Drainage District. An agency of GVRD.

HCFC	Hydrochloro-fluorocarbons. A family of refrigerants having a shorter atmospheric lifetime and lower ozone depletion potential than CFC's. R22 is the most common HCFC in use.
IQB	Individual Quick Blanch. A vegetable blanching technology that does not require the use of large volumes of hot water. Steam blanching may be regarded as a form of IQB technology.
IQF	Individual Quick Freeze. A high speed freezing process where individual particles or portions of food products are frozen prior to packaging.
L/kg	Litres per kilogram: unit used to define water use per weight of product manufactured.
m^3	Cubic metre. Refers to volumetric measure.
mg/L	Milligrams per litre. Unit of measurement of concentration of a substance in a solute.
NFPA	National Food Processors Association (USA)
O&G	Oil and Grease. Measure of oil and grease content in effluent due to product or equipment lubricants in the wastewater.
P	Pressure in kPa (kilopascals), gauge where atmospheric pressure is datum.
P2	Pollution Prevention. The prevention of pollution at the source rather than at the end of a process system.
pH	Measure of acidity or alkalinity of solution or effluent. pH 7.0 is neutral whereas pH < 7.0 is acidic and pH > 7.0 is alkaline.
R22	Refrigerant 22 is a common HCFC refrigerant with relatively low ozone depletion potential.
RBC	Rotating Biological Contactor. A biological or tertiary effluent treatment technology.
T	Temperature in EC
TS	Total Solids
TSS	(Also SS) Total Suspended Solids
tonne	Metric ton or 1,000 kg
USDA	United States Department of Agriculture
USEPA	See EPA; United States Environmental Protection Agency
USG	US gallon. Refers to volumetric measure.
USgpm	US gallon per minute. Refers to volumetric rate of flow.

1.0 INTRODUCTION

1.1 TERMS OF REFERENCE

Environment Canada states the following in the opening sentence of their policy document, *Pollution Prevention - A Federal Strategy for Action (1995):*

> *The federal government believes that pollution prevention is the most effective means of protecting our environment, eliminating costly waste, and promoting sustainable development. Pollution prevention focuses on avoiding the creation of pollution, rather than trying to manage them after they have been created.*

Through the Canadian Council of Ministers of Environment (CCME), the federal and provincial governments have affirmed a National Commitment to Pollution Prevention. Within this plan, there is a recognition of the importance of private industry in pollution prevention. Governments have articulated their support of industrial pollution prevention by:

- Developing innovative pollution prevention programs;
- Promoting pollution prevention through refocused research, development and demonstration initiatives;
- Promoting the adoption of sustainable production in industrial and manufacturing processes; and
- Implementing economic instruments that will result in pollution prevention.

Environment Canada, through the Fraser Pollution Abatement Office, has commissioned the production of a number of pollution prevention (P2) manuals for various industrial sectors that discharge effluent to the Fraser River in the lower Fraser Valley. This manual for the fruit and vegetable processing industry is part of this effort. At this time, there is no Code of Practice developed for this industry. Part of the scope of this manual is to present background information on the industry, current practices and available best management practices (BMPs).

1.2 POLLUTION PREVENTION

Pollution prevention focuses on preventing the creation of pollution. It is the preferred tool to protect the environment rather than develop end-of-pipe treatment for treating the waste stream after pollutants are created in the process plant. Pollution prevention is the use of processes, practices, materials and energy to avoid or minimize the creation of pollution and wastes.

Some examples of pollution prevention are indicated in Figure 1.1. For example, the practice of dry clean-up of the plant floor, rather than using large volumes of water, is an example of training, and operating and maintenance procedures shown in the box labelled, Improved Operating Practices. This simple improvement is categorized as a Process Change which can significantly affect Source Reduction of effluent and may also improve the quality of the solid residuals (reduced moisture content of the solid waste and increased recovery).

1.3 PROJECT OBJECTIVES

The overall objective in the preparation of this manual was to:

- Summarize the industry profile for fruit and vegetable processors and identify environmental issues unique to this industry.

- Provide a step-by-step environmental review procedure to enable plant operators to conduct an unbiased, voluntary self-review of pollution generated by their facilities. Worksheets for conducting environmental reviews were to be included, as well as a method for interpreting the data collected during the environmental reviews.

- Provide a guideline for the industry for the development of pollution prevention plans. A list of BMPs was to be included.

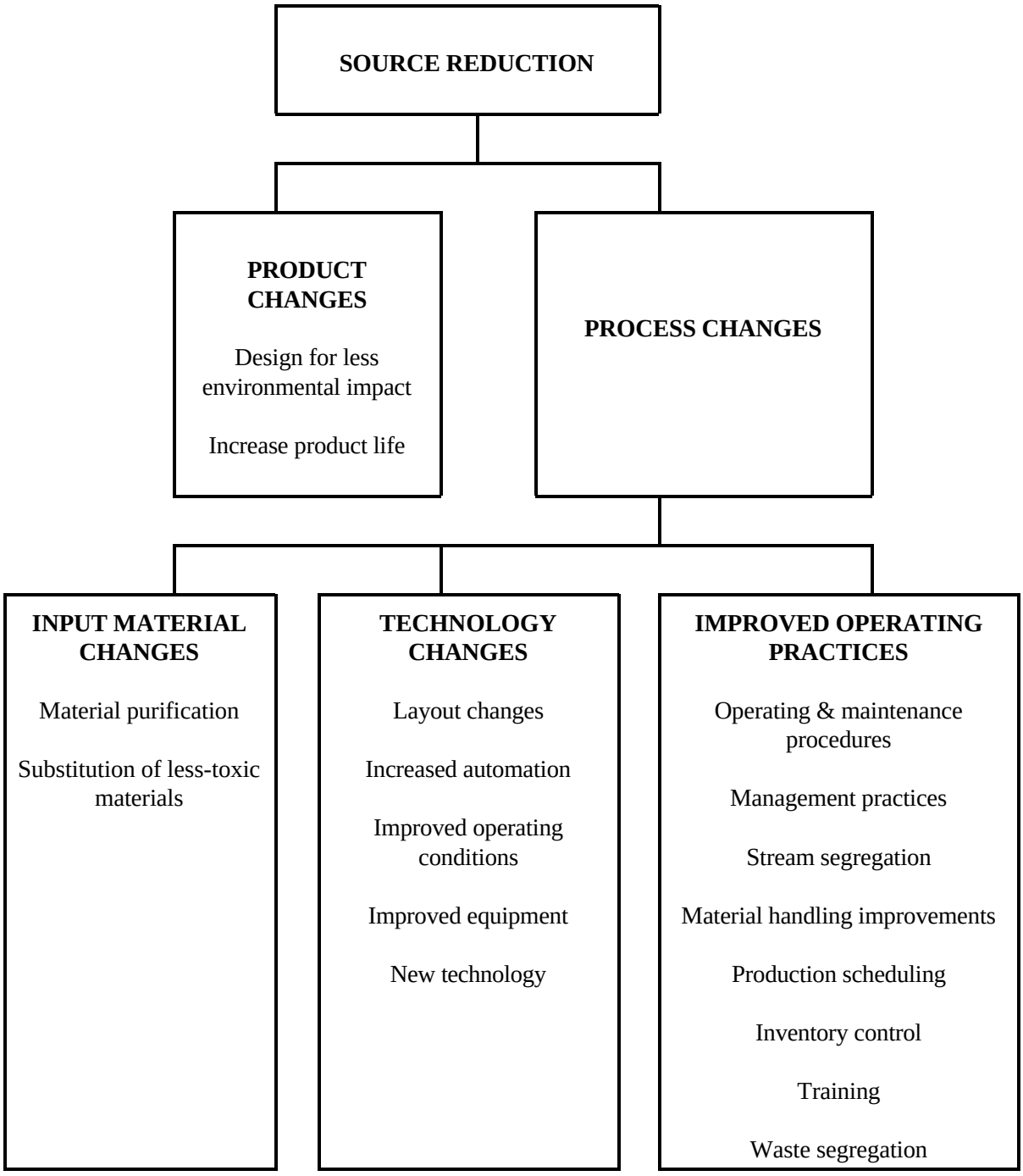
1.4 APPROACH

The summary of the industry profile is limited to fruit and vegetable processing plants located in the lower Fraser Valley. These plants include only those that receive fresh products from the field and where crops are washed and processed prior to freezing or canning.

Fruit processing includes only berry processors where fresh raw products are received from the field, washed and frozen. Due to the limitations of our growing season, the operations are restricted in their production from May to November. Cranberry processing is not included in this manual since there is only one plant and technically no processing takes place other than washing the raw product prior to shipment to the USA for processing.

The single major mushroom processor operates year 'round since fresh mushroom production continues throughout the year in controlled, protected environments.

Secondary processors, where primary products are manufactured into jams, jellies, condiments, soups, etc., are not included in this manual. These operations are relatively clean and the only process effluent generated is due to clean-up of the equipment.



Source: Facility Pollution Prevention Guide (USEPA/600/R-92-088)

Figure 1.1: Pollution Prevention Methods

There is an increasing trend to on-farm and cottage processing industries and this aspect of British Columbia processing has not been included in this manual.

The information contained in this manual is based on both a literature review of work in this field from other major processing areas (California, Oregon, Washington, Wisconsin, etc.) and a review of the state of the industry in British Columbia and, more specifically, 15 fruit and vegetable processors in the lower Fraser Valley. All the companies and cooperatives that are known to have processing operations were approached by telephone and by mail. A questionnaire was issued requesting data regarding production and effluent and residual handling.

Site visits were made to six of the nine respondents to walk through the plant and discuss the state of the industry and environmental issues specific to each of the operations.

1.5 HOW TO USE THE MANUAL

The fruit and vegetable processing industry in the lower Fraser Valley , although small in scale compared to other production areas outside of BC, generates effluent and residuals from processing operations. This manual shows that a waste audit or environmental review is the first stage to assess environmental compliance (against a regulatory standard or industry normals) and to determine if there are pollution prevention opportunities. The environmental review program is a systematic, planned procedure put in place to identify ways to reduce, recycle or eliminate waste and residuals.

Each of the following five sections of the manual offers information to assist the management and staff of processing operations, as follows:

- Section 2 has an industry profile and the results of the survey of local processors;
- Section 3 discusses some of the environmental issues facing this industry;
- Section 4 is a discussion of how to initiate and carry out a pollution prevention program;
- Section 5 is a discussion of the rationale behind environmental reviews and a methodology to conduct environmental reviews with the aid of included worksheets; and
- Section 6 lists a number of suitable pollution prevention options and best management practices for this industry.

In addition, there are various data tables and references included in the appendices that support the discussion in the manual.

2.0 INDUSTRY INFORMATION

2.1 BACKGROUND TO THE FRUIT AND VEGETABLE PROCESSING INDUSTRY

This processing sector was established to serve the needs of the British Columbia producers of the crops grown and to supply the local and export markets. It is a productive and yet very small industry compared to other production areas in the USA and elsewhere in the world. There are four broad groups of fruits and vegetables grown and processed in BC: tree fruits, berries, grapes and vegetables.

2.1.1 Tree Fruits

The Okanagan Valley produces over half of Canada's pears, cherries, prunes and plums and all of Canada's apricots. Despite this, our prime fruit growing region is on the northern fringe of commercial production in North America. There is virtually no tree fruit production in the lower Fraser Valley and, therefore, tree fruit processing is not discussed in this manual. Table 2.1 indicates that only 3% of BC's production of tree fruits is from the Mainland-Southwest production region. Note that the revenue figures in Table 2.1 are for total farm revenue for 1992 and reflect direct sales, sales to fresh market wholesale suppliers and sales to processors.

Similarly, although not shown in Table 2.1, the primary production and processing region for grapes is in the Okanagan, with virtually no production and few processors in the lower Fraser Valley. Of the 4,000 tonnes that are produced in BC, over 90% are processed into wine which is not part of the scope of this manual.

TABLE 2.1: 1992 TREE FRUIT PRODUCTION - BC

REGIONS	Tree Fruits			
	Farms	%	Revenue	%
North Coast	7	0	$70,000	0
Bulkley-Nechako	0	0	$0	0
Peace-Northeast	0	0	$0	0
Cariboo-Central	2	0	$0	0
Thompson-Okanagan	1,942	85	$73,440,000	93
Kootenay	116	5	$2,050,000	3
Mainland-Southwest	118	5	$2,250,000	3
Vancouver Island - Coast	113	5	$1,100,000	1
TOTAL	**2,298**	**100**	**$78,910,000**	**100**

2.1.2 Berries

Although there is significant berry production in the Okanagan, 85% of the production occurs in the lower Fraser Valley. The berry processing industry is, therefore, centred in the Fraser Valley. The production figures for berries grown in BC are presented in Table 2.2.

Blueberries: BC supplies 95% of the nation's cultivated blueberries, 95% of which comes from the lower Fraser Valley. Seventy percent of the crop of 20 million lb. is processed and the balance is sold to the fresh market. Most of this processing capacity is with one processor.

Strawberries: In BC, we produce about one quarter of the nation's total strawberries; however, we consume far more than we can produce, with the bulk of the product coming from California, eastern Europe and Mexico. About 75% of the crop grown in BC is processed by about six processors in the lower Fraser Valley.

Raspberries: Although raspberries can be grown in several production regions of the province, over 98% of the commercial crop is produced in the lower Fraser Valley. Production has been as high as 44 million lb., with about 90% going to processors for frozen berries, jam, juice and fillings.

Cranberries: As stated in Section 1, cranberries are not covered in this manual because the crop, although significant in the lower Fraser Valley, is not processed in BC. Cranberries are one of BC's largest crops in terms of value and volume, since over 37 million lb. are harvested, with a value of about $25 million. Over 95% of the crop is exported fresh for processing in Washington state.

TABLE 2.2: 1992 BERRY PRODUCTION - BC

REGIONS	**Berries**			
	Farms	%	Revenue	%
North Coast	4	0	$10,000	0
Bulkley-Nechako	0	0	$0	0
Peace-Northeast	7	1	$0	0
Cariboo-Central	3	0	$0	0
Thompson-Okanagan	174	20	$8,100,000	13
Kootenay	10	1	$100,000	0
Mainland-Southwest	620	70	$54,000,000	85
Vancouver Island - Coast	69	8	$1,100,000	2
TOTAL	**887**	**100**	**$63,310,000**	**100**

2.1.3 Vegetables

Although there is commercial vegetable production in all regions of BC, 79% of the value of the crop is produced in the Mainland-Southwest growing region. (See production data presented in Table 2.3.) There are relatively few commercial processors in the region and this number is decreasing as the industry rationalizes under Free Trade. It is important to recognize the relative scale of the BC industry compared to the industries in Washington, Oregon, Wisconsin and California. In each of those four states, the production capacity is in the order of ten times the capacity in BC. The relatively low value of the Canadian dollar keeps the industry alive at present.

TABLE 2.3: 1992 VEGETABLE PRODUCTION - BC

REGIONS	**Vegetables**			
	Farms	%	Revenue	%
North Coast	4	0	$210,000	0
Bulkley-Nechako	1	1	$60,000	0
Peace-Northeast	8	1	$150,000	0
Cariboo-Central	21	4	$250,000	1
Thompson-Okanagan	162	27	$6,210,000	12
Kootenay	32	5	$1,630,000	3
Mainland-Southwest	289	49	$41,250,000	79
Vancouver Island - Coast	74	13	$2,750,000	5
TOTAL	**591**	**100**	**$52,510,000**	**100**

2.2 FRUIT AND VEGETABLE PROCESSORS OF THE LOWER FRASER VALLEY

A list was developed of fifteen processors in the lower Fraser Valley. All were contacted by mail and by telephone to seek their co-operation and participation in the production of this manual.

There currently exists three major vegetable processors in the Fraser Valley with the withdrawal of Royal City/Delnor Frozen Foods from processing. The remaining three (Fraser Valley Foods, Snowcrest and Lucerne) all operate freezing plants for processing vegetables and some berries into frozen products. Only Fraser Valley Foods continued to operate their cannery in Sardis through 1995 for limited production of asparagus, corn and some fruits.

Fraser Valley Foods' freezing plant in Chilliwack was recently closed. There was a recent announcement by the parent company of Fraser Valley Foods that the Sardis operation will also be closed prior to another processing season in 1996. This leaves two major processors operating in the lower Fraser Valley.

Two other significant operations receive locally grown vegetables from growers, wash, grade and pack for the fresh market, but do not process by canning or freezing. There exists a plant in Delta where vegetables are processed into snack foods. In addition, a large co-operative operates a cannery for processing mushrooms.

Of the ten berry processors contacted, information was made available from five. As indicated, one of the processors receives and cleans cranberries prior to exporting for processing in the USA.

Not addressed in this manual is the situation of the on-farm grower-processor who may pack his own produce into frozen products, jams, jellies and fillings. The trend appears to be toward an increase in these types of operations, particularly as the major processors cease operations.

2.3 TYPICAL PROCESS FLOW DIAGRAMS

In general, the processes involved in fruit and vegetable processing are shown in the simplified process flow diagram, Figure 2.1. The processes include cleaning the raw product as received from the field, inspection (culling, trimming, sizing), blanching (in the case of vegetables for freezing), cooling (after blanching), and freezing. Subsequent to freezing, the product is inspected, packaged, cased and stored.

The peeling stage, shown in Figure 2.1, is normally depicted in the preparation stage. In the case of potato processing, which is not done in BC in a significant volume, the peeling stage is a critical unit operation that is the source of significant wastewater and residuals.

Note that in Figure 2.1, the water stream is shown as single pass use of fresh water at each unit operation. This is the case for all of the processors who participated by submitting data. Figure 2.2 shows the identical typical process line but the reuse of water is indicated. Countercurrent recycling of water from the latter stages of the process, fed forward to the initial stages of processing, is more typical of larger processing operations in other food processing areas, particularly in the USA.

2.3.1 Berries

The typical process for berries is very simple. The fruit is received from the field in flats and dumped on a receiving belt. The light trash is first separated from the product by air separation. The berries are conveyed on a belt under a bank of washing nozzles to clean the crop. Manual grading and inspection takes place after washing. The berries are then frozen in an air-blast tunnel freezer (IQF). (Note that there is no blanching stage for berry processing.) Finally, the berries are packaged, cased, palletized and held in freezer storage. In the process flow diagram for strawberries (Figure 2.3), three end-product streams are shown

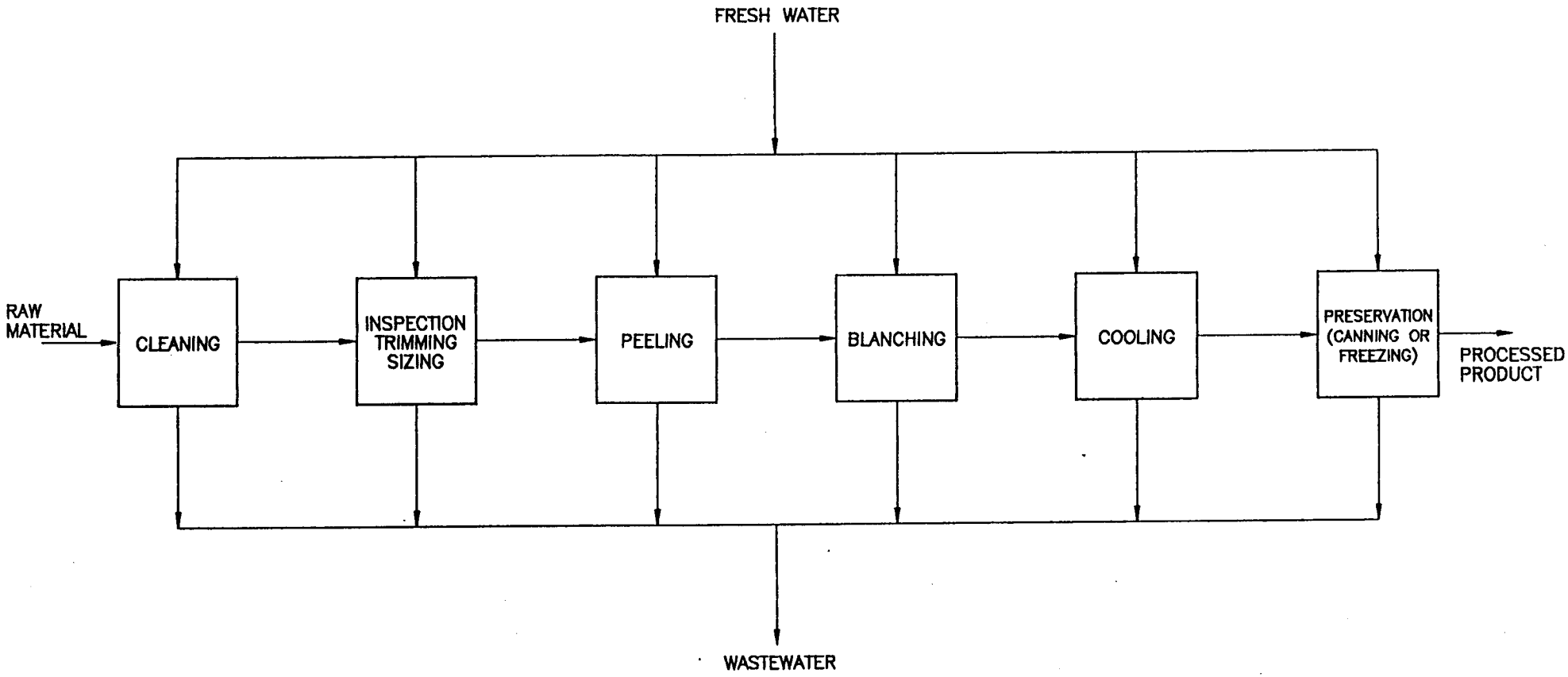


FIGURE 2.1: ONCE-THROUGH WATER FLOW PATTERN FRUIT AND VEGETABLE PROCESSING

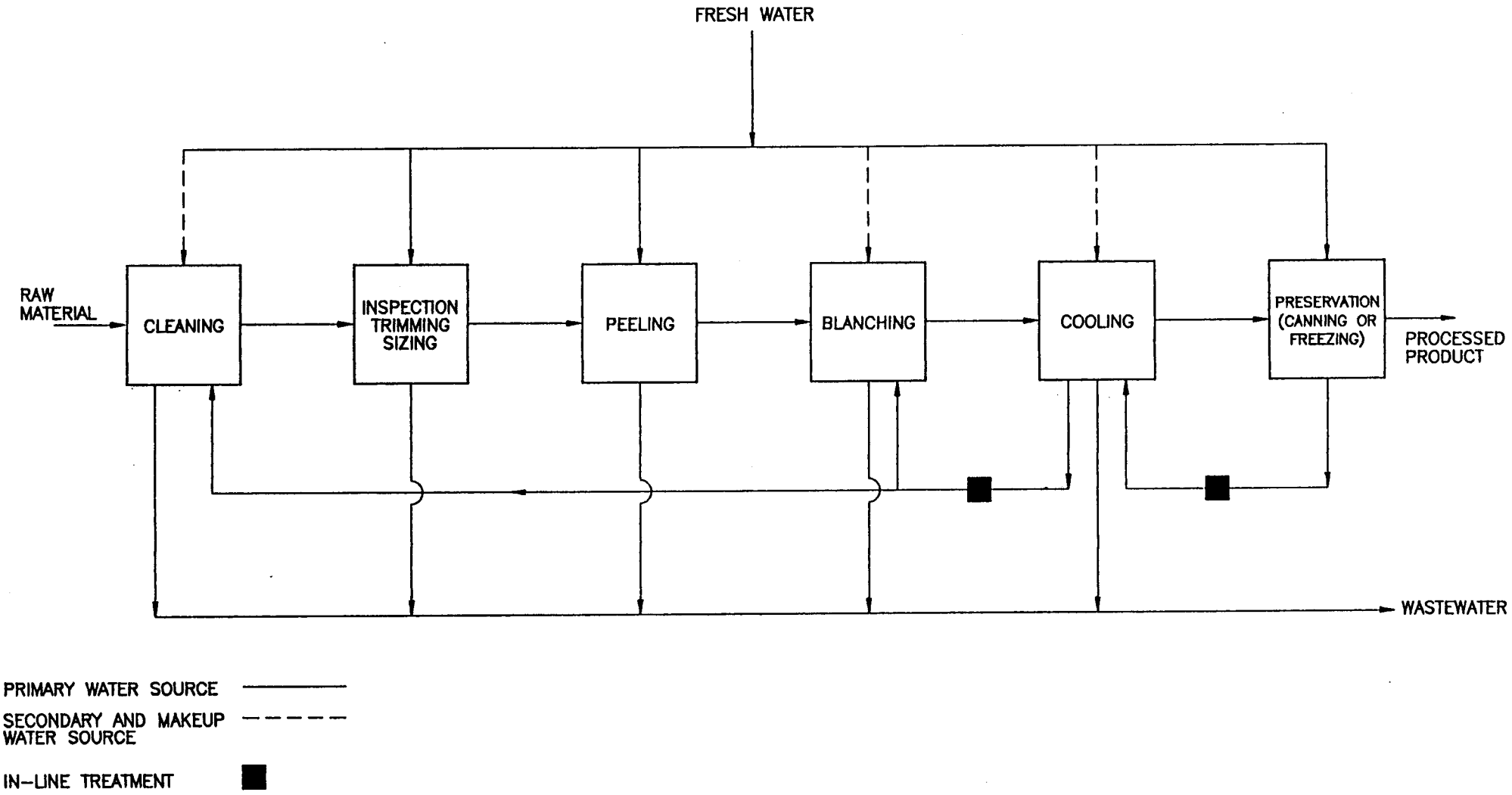


FIGURE 2.2: COUNTERCURRENT WATER RECYCLE FLOW PATTERN FRUIT AND VEGETABLE PROCESSING

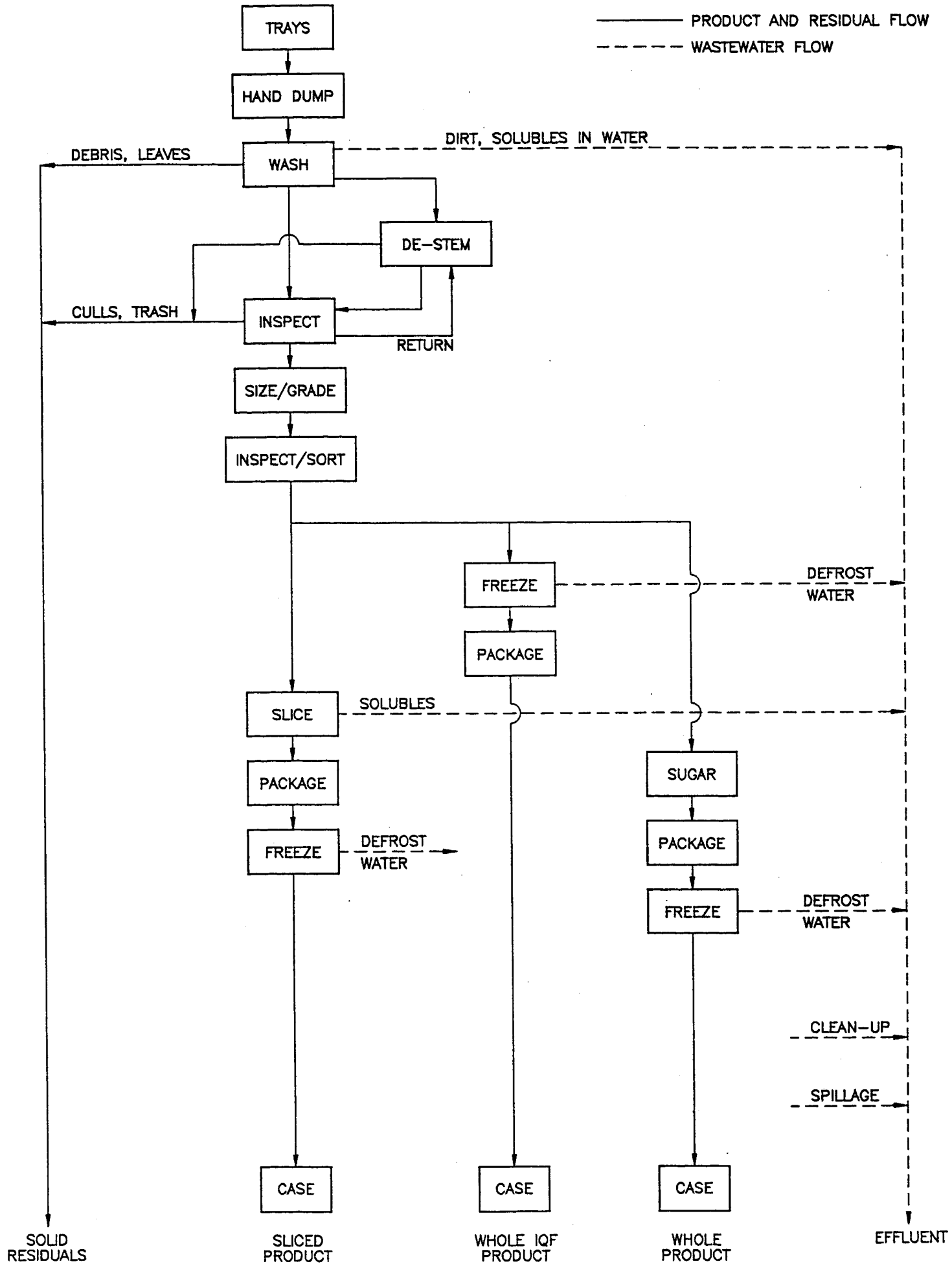


FIGURE 2.3: PROCESSING SCHEMATIC FLOW SHEET - STRAWBERRIES

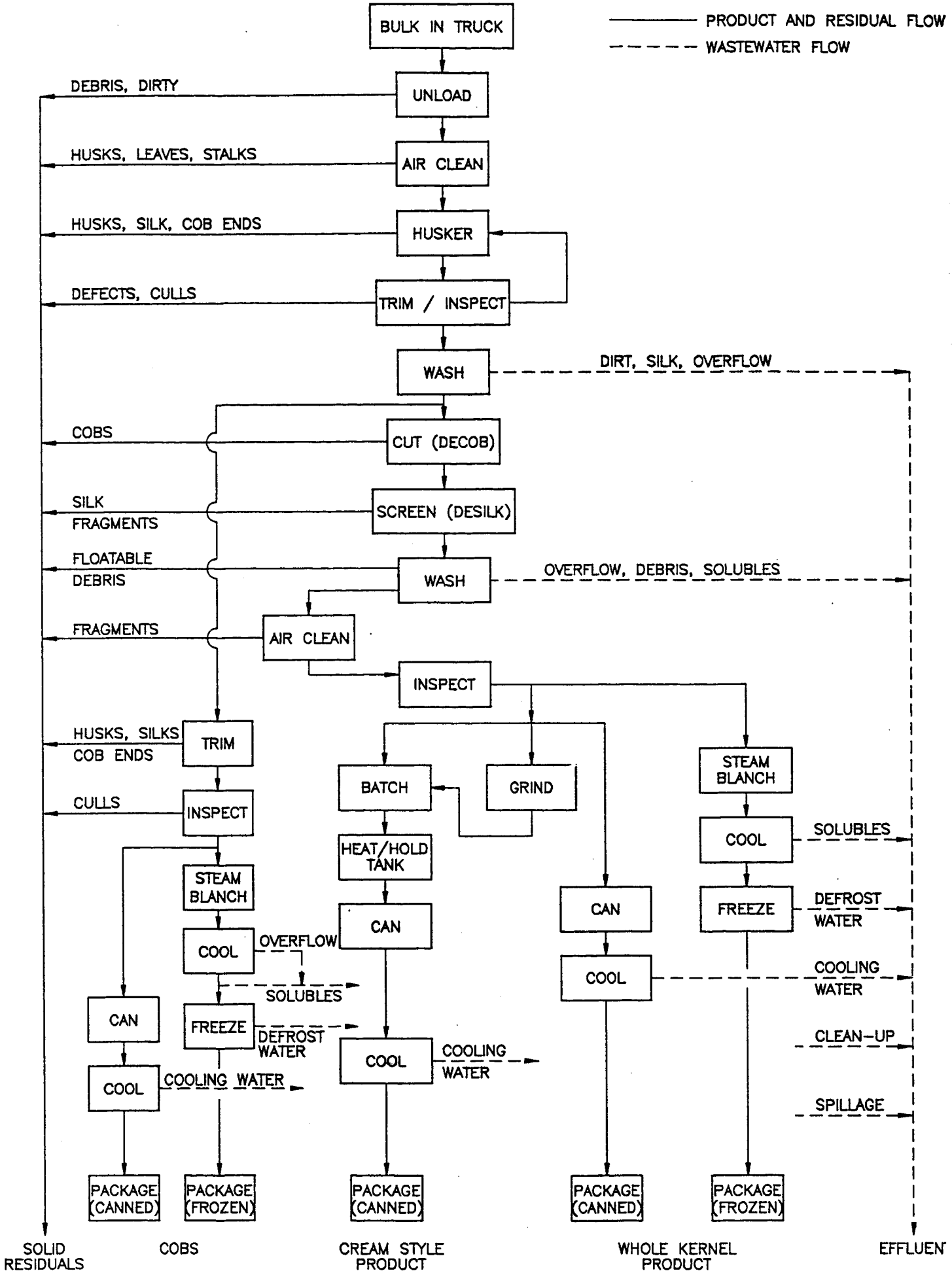


FIGURE 2.4: PROCESSING SCHEMATIC FLOW SHEET - CORN

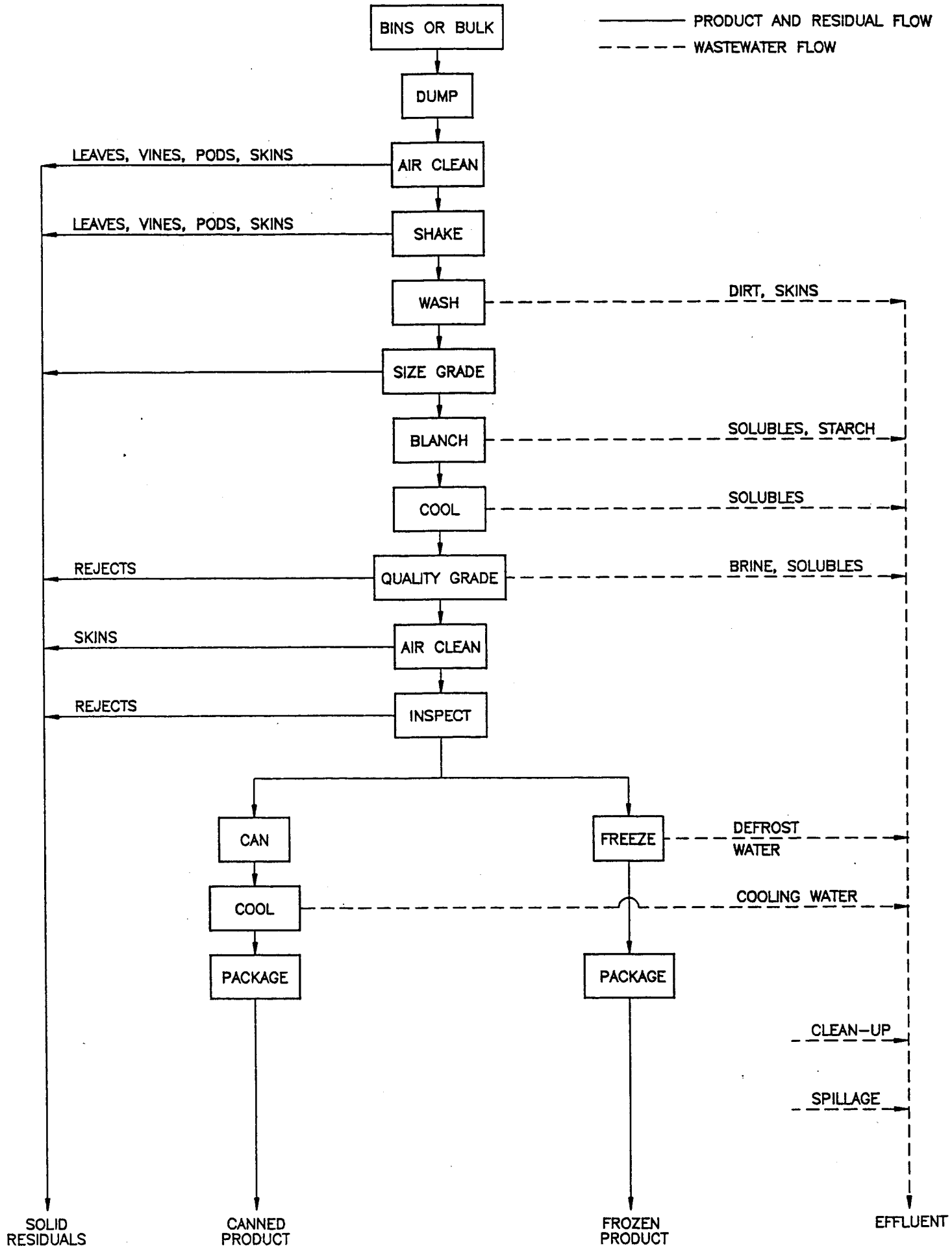


FIGURE 2.5: PROCESSING SCHEMATIC FLOW SHEET - PEAS

flowing to the bottom of the diagram: sliced frozen berries frozen in packages; whole berries IQF-frozen and then packaged; and whole product frozen in the package.

Water is only used in the wash stage (which must be fresh, clean water) and in plant clean-up operations. In addition, prior to being returned to the field, the flats are washed in a wash tunnel. Recycled water can be used in this operation.

2.3.2 Vegetables

Since the only vegetable cannery in operation in the Fraser Valley was used until 1995 only for short runs of very few products, the focus of this discussion is on the frozen vegetable processing operations. The process consists of receiving the fresh product from the field, air separation of light trash, washing, preparation by sizing or trimming, blanching in steam or hot water immersion, cooling, and freezing by fluidized bed air blast (a form of IQF freezing). Finally, the product is packaged, cased, palletized and held in freezer storage.

Water usage is greatest in the washing and cooling stages. In addition, water is used in lesser quantities in blanching and plant clean-up. See process flow diagrams Figures 2.4 and 2.5 for corn and peas, respectively. The process flow diagram for corn, Figure 2.4, appears complex because of the variety of product streams shown flowing to the bottom of the diagram. Whole cob corn (canned and frozen), canned cream-style corn and whole kernel product (canned and frozen) are all shown on this diagram.

For the production of frozen corn, which is done currently by only two processors in the lower Fraser Valley, there is a significant effluent load due to the fact that upon cutting the kernels off the cob, there is a cut face of the kernel which is subject to loss of internal moisture and soluble starches. Every washing, blanching and cooling operation subsequent to cutting yields high organic loads in the effluent.

2.4 INDUSTRY PRACTICE IN BC

The plant data of nine of the processors are included in Appendix A. The data are incomplete for the industry in the lower Fraser Valley and not all of the individual plant data sheets are as complete and as detailed as would be required to obtain conclusive information. It would be instructive, for example, to know the flows of water and waste for each of the commodities processed. It is understood that these records are not always kept by the processors or are available from them. For the two major frozen vegetable processors, it appears that fresh water consumption is in excess of 2 USG per lb. (17 L/kg) of product processed. The BC data are not consistent nor extensive enough to draw conclusions for the other plants. Water consumption data for operations in the USA are included in Section 3. (See Table 3.1.)

The following discussion summarizes the current practices of this industry. The local industry is characterized as being small scale and therefore inefficient with respect to plant and equipment utilization. Water supplies are of good quality and abundant.

2.4.1 Berries

The berry processing industry in the lower Fraser Valley uses very little water and generates a relatively small quantity of waste. Typical of berry processing lines, Plant No. 4 processes raspberries using only 40 USgpm for a specific water rate of just 0.17 USG/lb. (1.4 L/kg). The water is used in washing the crop in a single pass; none is recycled. Scrutiny of the data for Plant No. 5, another berry processor, shows that the washwater flow is only 1 Usgpm.

This reduced water consumption is due to the crop being blueberries, which are not as rough or difficult to clean as other berries and are packaged as dry as possible.

Water is also used in plant clean-up and in flat washing. The flat washing lines generally involve recycled water and very little fresh water is used in these operations. Dry pick-up is used to some extent prior to plant wash-down.

The plant effluent does not receive treatment and typically is discharged to the local sewer with no pre-treatment. Due to the nature of the discharge, there is no expressed concern over effluent quality and permit parameters are being met.

In two cases for major berry processors, the raw product receiving areas were under cover, thereby reducing the load on the sewer system due to contaminated runoff from receiving areas. One of the reporting berry processors had installed two small settling basins for solids separation.

There are some processing plants that are not located near sanitary sewers. Effluent from these plants are typically discharged to a small, excavated, un-lined holding pond. From the pond, effluent is drained to the municipal ditch, exfiltrates to groundwater or is pumped to irrigate agricultural fields. It is probable that there are no discharge permits for these practices for any of the plants.

2.4.2 Vegetables

Vegetable processing in the lower Fraser Valley is somewhat more complex than berry processing and requires greater quantities of water. Most of the water is required for washing the raw products (on average, of the two plants reporting, 46% of the water is used in washing), followed by plant clean-up (21%), cooling (15%), blanching (12%), and other uses including domestic (6%). Water use is not an issue to these processors since the supply is abundant and the cost is relatively low. In the case of the major processors who provided information, a substantial proportion of fresh water used is from on-site wells.

In all cases of the major vegetable processors, raw products are received outside the plant building in the open, resulting in the increased risk of releasing contaminated runoff to the storm sewer.

Pre-treatment of effluent is limited to coarse screening at the floor drains and collection sumps followed by finer screening utilizing rotary screens. In one case (not reporting), aerated ponds are utilized prior to discharging the effluent to surface receiving water or to agricultural fields during the growing season. In another case (not reporting), a snack food processor utilizes hydrocyclones to separate solids, particularly starch particles, from the effluent. Oil and grease are reduced using a DAF cell prior to discharge to the sanitary sewer. The plants reporting operate in compliance with discharge permit or municipal bylaw conditions. If there are out-of-compliance conditions, they occur occasionally and particularly during peak production or when corn is being processed.

All stages of washing and preparation utilize fresh water and, generally, no water is recycled. Only one processor recycles water in a two-stage counter-current washing system. Note that this particular wash line is for potatoes only for fresh packing and not for processing. No processor in the lower Fraser Valley utilizes recycled water in any part of the processing lines.

Blanching systems observed all utilized steam to reduce water usage and to speed blanching. Pea processing still requires water immersion blanching. No processors reported using IQB blanching nor dry blanching.

Cooling water is required to be clean as it comes into direct contact with the food. All processors utilize fresh, uncooled water for cooling, none of which is recycled for any part of the process.

Most processors practice dry clean-up prior to using high pressure water for sanitation. The clean-up operations are critically important to maintain quality and therefore significant time and water are expended in this operation.

Only one processor reported a water conservation program where clean-up operations are rationalized and cooling water for mechanical equipment is being recycled. The impetus for the program is to reduce water consumption to less than 300 m^3 per 30-day period in order to seek exemption from the requirement to hold a waste discharge permit in the GVRD.

3.0 SUMMARY OF ENVIRONMENTAL ISSUES

3.1 OVERVIEW

Processing of fruit and vegetables typically results in the generation of large volumes of solid wastes and process wastewaters containing organic matter and suspended solids. Process wastewaters are generated from contact of water with fruits and vegetables during washing, blanching, cooling and other processing steps. The resulting wastewater is typically high in organic matter and solids. The major pollutants in the wastewater stream that can cause environmental problems are high levels of biochemical oxygen demand (BOD), and total and suspended solids (TS and SS). High/low swings in pH are not a problem for fruit and vegetable processing. Intermediate pollutants which can cause environmental problems, but are not of concern for fruit and vegetable processors, are chemical oxygen demand (COD) and oil and grease.

Efforts to reduce the contaminant levels (as measured by the above parameters) of wastewater discharges typically focus on reducing BOD levels, solids content, as well as lowering water consumption. Reducing water consumption reduces pollution by decreasing the quantity of water in contact with the product. The risk of water reduction in this industry is the potential compromise to sanitation and product quality. The secondary benefit to water reduction is reduced capital and operational costs since the hydraulic flow through the plant can be reduced.

Pesticide residues brought into processing plants are not an issue since vegetables are received ready to process. Strict quality control on pesticide application is checked by field staff, and products, application rates and days to harvest are enforced by regulation. The in-plant washing operation is not designed for rinsing pesticide residue off the products, but for removing foreign solid material. Since pesticide residue in the product is controlled by the Health Protection Branch regulation to fractions of parts per million, the potential levels of pesticide residue in wastewaters will effectively be zero.

Chlorine sanitizers, particularly in the form of dilute liquid sodium hypochlorite, are used extensively in clean-up operations in all processing plants. They are not used to wash the crop except in the case of washing products for the fresh market. Typically, a 6% solution will be diluted to 1:50 in the final clean-up water and for wash-down of equipment. This concentration normally leaves only 0 to 3 mg/L of free chlorine residual in the effluent.

Solid wastes from this industry include vegetable and fruit trimmings generated in the cutting/grading and trimming areas. Most of these residuals are returned to the fields as organic fertilizer.

In addition to the above waste streams, this industry also generates waste streams from cleaning and sanitizing operations, equipment maintenance, packaging, printing, laboratory analyses and stormwater. Packaging/receiving wastes include cardboard containers, waxed cardboard containers, wooden crates, baskets and pallets, and plastic materials.

3.2 WATER CONSUMPTION AND WASTEWATER CHARACTERISTICS

Water consumption rates and wastewater characteristics vary greatly within the fruit and vegetable processing industry.

Water consumption rates vary depending upon:

- type of fruit or vegetable processed;
- the quality and conditions in the field being harvested;
- water conservation techniques employed or not employed;
- processing technology used;
- type of product produced; and
- plant size.

Wastewater characteristics vary depending upon:

- influent water quality;
- water consumption rate;
- type of fruit or vegetable processed;
- raw - feedstock/product condition (ripeness, damage), and variety;
- product conveying systems (countercurrent vs. single pass fluming, dry conveying, pneumatic conveying);
- process methods (blanching, peeling);
- clean-up methods (dry vs. wet, detergent, disinfectant);
- batch dump frequency (brine and caustics that may be used in processing);
- frequency and duration of shutdowns;
- type and condition of equipment; and
- management and staff training.

Table 3.1 shows typical water consumption rates and wastewater characteristics for a variety of fruit and vegetable processing operations. The data in the tables were obtained from literature.

For lower Fraser Valley processors, water consumption is in excess of 17 m^3/tonne for frozen vegetable processing. Note that economies of scale will favour water conservation for the larger processing plants in the USA, from which Table 3.1 is derived. In addition, the USA plants practice water recycling, driven primarily by the cost and availability of water.

TABLE 3.1: WASTEWATER CHARACTERISTICS, FRUIT AND VEGETABLE PROCESSING - LITERATURE DATA						
	FLOW (m^3/tonne)		BOD (kg/tonne)		SS (kg/tonne)	
Lambert Cherries						
Pitter Effluent	4.5	3.0-7.9	10.7	8.8-13	0.53	0.3-0.88
Total Plant Effluent	3.8	2.1-5.3	10.8	8.8-14	0.54	0.3-0.88
Corn						
Total Plant Effluent	5.5	3.4-8.3	13	13-14	-	-
Beets						
Beet Wash	1.2	0.9-1.8	0.7*	0.04-3.4*	-	-
Beet Blanch & Peel	2.8	2.1-5.6	27.6*	2.3-52	-	-
Total Plant Effluent	6.9	5.9-8.3	32	30-35	-	-
Royal Anne Cherries						
Pitter Effluent	8.3	3.1-15.4	7.4	5.4-9.1	0.42	0.06-0.8
Stemmer Effluent	2.4	1.9-2.8	0.19	0.1-0.25	0.01	0.01-0.18
Total Plant Effluent	6.3	4.2-8.1	7.8	5.6-9.7	0.43	0.08-0.8
Snap Beans						
Washing/Grading Effluent	2.2	1.9-2.5	0.33	0.2-0.5	1	0.63-1.8
Blanching Effluent	0.4	0.2-0.6	0.8	0.5-1.1	0.1	0.08-0.13
Total Plant Effluent	10.4	9.0-12.2	1.8	1.3-2.8	1.3	0.78-2.3
Bartlett Pears						
Ewald Peeler Effluent	5	4.0-6.5	3.7	2.2-5.1	0.18	0.09-0.33
Contour Peeler Effluent	2.1	1.6-2.8	8.5	6.5-11.5	1	0.79-1.4
Total Plant Effluent	11.1	6.9-13.5	14.8	11.4-18.1	1.4	0.95-1.9

Source: Soderquist, Blanton and Taylor. 1974. Characterization of Fruit and Vegetable Processing Wastewaters. (Department of Food, Science and Technology, Oregon State University).

* Values are calculated using formula BOD/COD = 0.87, and measured values for COD. COD not reported.

All results are per raw product tonne.

TABLE 3.1 NOTES:

1. Other parameters available included COD, solids (total, suspended and settleable), nitrogen (total, nitrate, nitrite, ammonia and organic), phosphorus (total, ortho, inorganic and total soluble), pH, dissolved oxygen and temperature.

2. Corn processing included husking, trimming, washing, cutting from the cob, de-silking, washing, canning and retorting.

3. Red beet processing included washing, peeling, blanching, slicing, canning and retorting.

4. Green bean canning process included initial washing, grading, snipping, cutting, blanching, canning and retorting.

5. Cherry processing involved blowing, stemming (Royal Anne only), grading, pitting, canning and cooking.

6. Bartlett pear processing included grading, peeling, brine fluming (NaCl), rinsing, trimming, chopping, canning and cooking.

3.3 SOLID WASTES

Vegetable and fruit processors strive to maintain long product shelf life and acceptable appearance and, therefore, as a whole, the industry has a high wastage factor. A high percentage of the raw product is lost before processing begins.

Typical solid wastes from the vegetable processing industry include lettuce and cabbage leaves, carrot tops, celery leaf and butts, yellow and decayed spinach leaves, broccoli and cauliflower stems and leaves, corn husks and cobs, unusable turnips, parsnips, brussels sprouts, radishes, onion peels, and other green leaf product waste.

Limited literature data are available on wastage rates for fruit and vegetable processing companies. Robillard and Martin (1993) indicated that, for one large multi-vegetable processing company, waste cuttings and trimmings averaged 70 tonnes for each 230 tonnes of raw product processed, or almost 30% by weight of the raw product stream. One of the major processors in the lower Fraser Valley disposes of approximately 100 tonnes of solid residuals per year on nearby agricultural land. This represents a waste factor of approximately 11% for the processor. Note that there is no corn processed at this operation. Data for some individual product streams are shown in Table 3.2, below:

Table 3.2: Typical Solid Waste Rates

	Production (Tonnes/Day)	Time	% Wastage
Cut/Cob Corn	275	July - October	60
Peas	70	May - June (6 wks.)	10
Mushrooms	10-16	Year Round	3-5

Source: Robillard and Martin, 1993

Solid wastes may be dry swept or mechanically conveyed to a dump truck or storage area outside of the facility. Solid wastes may also be washed down floor drains and contribute to organic and solid loadings in the wastewater.

Solid waste may be hauled away for use as cattle feed, fertilizer or compost. Most of the solid residuals from lower Fraser Valley plants are applied to agricultural land as organic fertilizer. Sludges from sumps and clarification ponds may also be field applied but, in small quantities, are typically trucked to landfill sites or the local commercial composting operation.

3.4 OTHER WASTES

This industry also generates waste streams from cleaning and sanitizing operations, equipment maintenance, packaging, printing, laboratory analyses and stormwater. The discussion on sanitizers is in the preceding Section 3.1. This manual does not comprehensively cover pollution prevention measures for other plant and office wastes; howeve,r there are many guides available for this purpose.

3.5 CURRENT REGULATIONS

Processing plants in the Lower Mainland may be regulated by the federal, provincial or municipal levels of government, depending on the location of the plant and the location of discharge of effluent. None of the 15 processors canvassed for this project fall under federal jurisdiction for effluent discharge permits.

3.5.1 Federal Acts and Regulations

Facilities located on federal Crown lands, such as land leased from the Coast Guard or from a Harbour Commission, fall under the jurisdiction of Environmental Protection of Environment Canada. These sites are not regulated by permits, but fall under the general conditions of the Canadian Environmental Protection Act and the Fisheries Act.

The Fisheries Act regulates the discharge and disposal of deleterious substances in Canadian fisheries waters on the federal level. Under Section 36 (3) of this Act, "...no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish..." A deleterious substance is defined as:

> "... any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man or fish that frequent that water, or any water that contains a substance in such quantity of concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, degrade or alter, form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man or fish that frequent that water..."

The Fisheries Act does not set up limits for any of the possible pollutants that fall under the definition of a deleterious substance. The pollutants that are generated from the fruit and vegetable processing industry that fall into the above definition include BOD, TS, SS, high/low pH and, to a lesser extent, oil and grease, nitrogen, phosphorus and additives.

Guidelines for Fruit and Vegetable processing industries are available under the Fisheries Act. The intent of the Guidelines is to indicate the level of effluent controls considered necessary for the federal government. Generally, screening and discharging through an outfall below low tide is acceptable. Good housekeeping is recommended.

Section 36 (3) of the Fisheries Act is co-administered by the Department of Fisheries and Oceans (DFO) and Environment Canada.

3.5.2 Provincial Acts and Regulations

For facilities that discharge effluent to water bodies, and are not located on federal Crown lands, a provincial Waste Management Branch Permit is required and will contain stringent operating and monitoring requirements.

A Waste Management Branch Permit is issued under the Waste Management Act, by the Department of Environmental Protection (formerly the Waste Management Branch) of the BC Ministry of Environment (BCMOELP). The Permits are issued by the regional offices and contain effluent concentration levels as well as operational and monitoring requirements that are determined on a site-specific basis. An inter-agency referral process established by the BC Ministry of Environment ensures that input and recommendations from federal, provincial and municipal agencies are considered during permit preparation.

In 1975, the BC Ministry of Environment published the *Pollution Control Objectives for Food Processing, Agriculturally Oriented, and Other Miscellaneous Industries of BC* . These Objectives provide guidance to Ministry staff when issuing effluent permits. As of this date, these Objectives have not been revised and re-issued, and now are of limited value as they have not been stringently applied.

The Objectives were intended to apply to effluent discharged to fresh and marine waters, excluding groundwater, and are expressed as a weight of contaminant per unit weight of production. Different limits have been set for various fruits and vegetables, as shown in Table 3.3. New and proposed discharges were to have met at least Level A Objectives. Existing discharges generally should meet at least Level C Objectives. The expectation was that, over time, the quality of the discharges were to have been upgraded through Level B and, eventually, to Level A.

The Ministry of Environment may set more stringent limits if receiving waters are affected detrimentally. The Objectives do not include additional guidelines for other commodities. Other parameters for other commodities are to be developed on an as-required basis.

Table 3.3 BCMOELP Objectives for the Discharge of Effluent to Marine and Fresh Waters From Fruit and Vegetable Processing Plants

Operation	Level / Parameter (kg/tonne product)	A	B	C	Monitoring Frequency
Asparagus, green beans, sauerkraut, spinach, tomatoes	BOD_5	0.6	3.5	7.5	weekly
	TSS	0.5	1.1	1.8	weekly
	pH	6.5-8.5	6.5-8.5	6.5-8.5	weekly
Apples, carrots, corn, parsnips, pumpkin, squash, white potatoes	BOD_5	1.1	6.5	14.0	weekly
	TSS	1	2.6	4.1	weekly
	pH	6.5-8.5	6.5-8.5	6.5-8.5	weekly
Apricots, peaches, peas, sweet potatoes	BOD_5	1.8	10.9	23.7	weekly
	TSS	1.1	2.8	4.5	weekly
	pH	6.5-8.5	6.5-8.5	6.5-8.5	weekly

Source: Pollution Control Objectives for Food-processing, Agriculturally Oriented, and Other Miscellaneous Industries of British Columbia, 1975.

To calculate BOD or TSS allowable concentrations in the wastewater in terms of mg/L, multiply the "level" in kg/tonne by the product flow in tonnes per year, divide by the total water consumption for that product in litres per year, and multiply the result by 1,000,000.

Example:

What is the level C objective for asparagus processing? A processor handles 500 tonnes per year and consumes 8,000,000 L of water in asparagus processing.

$$\text{Maximum allowable BOD} = \frac{(7.5)\,(500)\,(1{,}000{,}000)}{(8{,}000{,}000)} = 470 \text{ mg/L}$$

The above calculation results in a reasonable value for allowable BOD of the discharge effluent which is achievable with typical practices in our industry.

Permits issued under the regulations of the Waste Management Act may include requirements for effluent monitoring and reporting. Generally, monitoring of effluent by the permittee is required quarterly but, in the case of sensitive environments, monitoring may be required monthly. Reporting is generally on a quarterly or annual basis.

The disposal of settling basin sludge may be addressed in the permit by indicating that solids disposal must be carried out in a manner or location approved by the Regional Waste Manager. In practice, disposal of sludge and solids is not closely monitored by the regulatory agencies and, generally, permittees are not obliged in the permit to report the volume or method of solids disposal.

As part of the regulatory approval process, a processor is advised to be fully aware of the operational and monitoring requirements in the discharge permit. During the permit review period, the processor is advised to discuss the site-specific features of their operation with the BC Ministry of Environment representative so that the permit accurately reflects their operation.

There is a fee for holding a Waste Management Permit and this fee is based on the volume and quality of effluent released to the environment. Operators should ensure that this information is correct.

One of the trends that may be observed in this industry over the next few years is the return to on-farm washing, grading and processing. Waste discharges from on-farm operations are exempt from the permit requirements of the Act, provided that the products processed are grown on the farm and that wastes are handled according to good practice and recycled to the land as organic fertilizer. This does not mean that nearby fields can be used as disposal grounds for process effluent or residuals. New operations and those existing operations that come under the scrutiny of the permitting authority in the area, will be expected to prepare a Best Agricultural Management Plan that will account for a proper agronomic balance between fertilizer value in the effluent and residual solids and the production capacity of the land.

3.5.3 Municipal and Regional Bylaws

The discharge of wastewater from fruit and vegetable processing plants to municipal sewer systems is generally regulated by municipal or regional sewer use bylaws. Typically, these bylaws do not refer to such effluents specifically, but include general restrictions on pollution limits for particle-size, total suspended solids (TSS), oil and grease (O&G), and biochemical oxygen demand (BOD).

In the Greater Vancouver area, discharges to sewers are regulated by the GVS&DD Sewer Use Bylaw No. 164. Fruit and vegetable processing effluents fall under the category of "non-domestic waste" and their discharge requires a permit if more than 300 cubic metres of effluent are discharged from a facility over any consecutive 30-day period, or the waste is "restricted". The waste is restricted if composite samples

taken, using the methods indicated in the notes to Table 3.4, exceed the values shown in the table. In addition, food waste particles are not allowed to exceed 0.5 cm in any dimension.

Table 3.4: GVS&DD Effluent Discharge Limits for Parameters Applicable to the Fruit and Vegetable Processing Industry

Parameter	One-Operating-Day Composite Sample	Two-Hour Composite Sample	Grab Sample
BOD_5 (mg/L)	500	1,000	2,000
pH	-	5.5-10.5	5.0-11.0
TSS (mg/L)	600	1,200	2,400
O&G (Petrol)	15	30	60
O&G (Total)	150	300	600

Source: GVS&DD Sewer Use Bylaw No. 164.

1 One-operating-day composite sample is a composite sample consisting of equal portions of grab samples collected at consecutive one-hour intervals over the duration of the operating day.

2 Two-hour composite sample is a composite sample consisting of equal portions of 8 grab samples collected at consecutive 15-minute intervals.

Fruit and vegetable processors that need to apply for Waste Discharge Permits can do so by obtaining an Application Form from the Air Quality and Source Control Department of the GVRD. There are currently application and annual fees for these permits; however, the GVS&DD is in the process of developing a fee structure for non-domestic waste discharges. A 1992 rate structure proposal called for a surcharge of $0.27/kg of TSS and $0.13/kg of BOD discharged (GVRD, 1992). The fees are proposed for TSS and BOD concentrations exceeding 200 mg/L. It is not known if or when such surcharge fees may come into effect.

4.0 DEVELOPING A POLLUTION PREVENTION PROGRAM

The rationale for implementing pollution prevention projects was discussed in Section 1. In this section, planning methodology is presented on how to implement a Pollution Prevention Program in your company.

Pollution prevention planning is a continual process. It has much in common with the planning that is already done for business operations. Pollution prevention planning results can affect many functional areas and, therefore, such planning should be integrated into an operation's overall business planning effort.

The major steps in a comprehensive Pollution Prevention Program are shown in Figure 4.1. These steps may be followed in the sequence shown or with the shortcuts or additional iterations shown by the dashed lines to suit the unique and individual needs of an operation.

For example, for a smaller company with limited resources, it may be appropriate to collect enough information during the preliminary review to proceed to defining pollution prevention options as the next step. A larger operation may implement preliminary and detailed reviews. The choice will depend on the company needs and resources.

The major steps in a Pollution Prevention Program include establishing and organizing the pollution prevention program, performing the environmental review(s), defining pollution prevention options, and implementing these prevention options. The process is repeated annually or bi-annually, as shown in Figure 4.1, depending on the company's needs. Repeating the cycle leads to improved environmental performance each time the process is repeated.

Each of the major steps is described in detail below.

4.1 STEP 1: ESTABLISH THE POLLUTION PREVENTION PROGRAM

4.1.1 Secure Management Commitment

In some companies, the initiative to implement a pollution prevention program will be made at the executive level. In other companies, the initiative may be from lower level managers or employees. In either case, it may be necessary to gather some initial information to demonstrate that pollution prevention opportunities exist and should be explored.

One way to gather information would be to carry out a preliminary review, or a pre-preliminary review. The procedures described in Section 5 could be followed to the extent necessary to determine whether to commit the resources necessary to develop and implement the pollution prevention program.

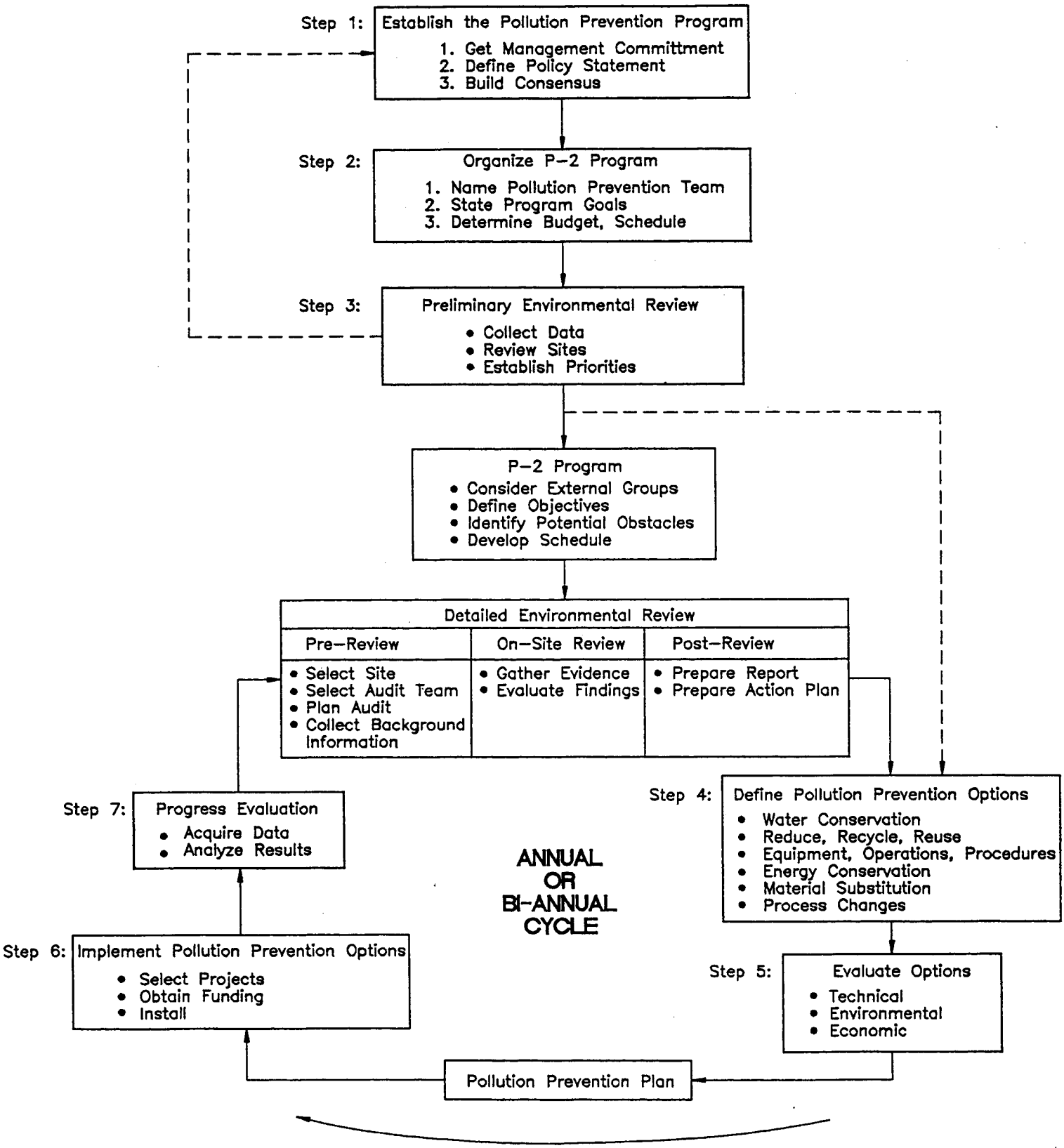


FIGURE 4.1: A COMPREHENSIVE POLLUTION PREVENTION PLANNING PROCESS

4.1.2 Develop a Policy Statement

Once it has been decided to pursue a pollution prevention program, senior management should convey the company commitment to the program, by issuing a formal policy statement to the employees.

The policy statement states why the Pollution Prevention Program is being developed, what is to be accomplished in qualitative terms, and who will do it. Policy statements will differ in level of detail, but should answer the following key questions:

- Why implement pollution prevention?
- What will be done to implement pollution prevention?
- Who will implement pollution prevention?

4.1.3 Build Consensus

It is important to publicize internally the company's commitment to pollution prevention and to encourage employee participation. How the policy and program are publicized will depend on the size and culture of the company. Meetings, news bulletins, or other vehicles of communication can be utilized. In any case, is important that a positive atmosphere is established and employees, who might be concerned about changes that may result from the program, be reassured.

Seeking employee participation may also elicit pollution prevention suggestions. One way to involve employees is to offer bonuses or awards to employees who find ways to prevent pollution. Announcing the awards in newsletters or on bulletin boards further publicizes the program. Pollution prevention might be included in job descriptions or performance evaluations.

4.2 STEP 2: ORGANIZE THE PROGRAM

4.2.1 Name the Pollution Prevention Team

Depending on the size of the company, the program may be managed by an individual or a team. The individual or team will have overall responsibility for developing and implementing the program. They should be chosen carefully as their capabilities and attitudes towards the program will be a major factor in its success. The individual or team members should have substantial technical, business and communication skills as well as a thorough knowledge of the company. The individual or team members should be highly supportive of the program. Individuals or team members may also be selected for their ability to "champion" the program in various production areas or to provide technical or business input.

If a team is required, then the responsibilities of each of the team members will be identified at this stage. A Program Leader will be named and will be responsible to keep the program on track, guide team members and facilitate the flow of information. Examples of team members include plant process engineers, environmental engineers, production supervisors, experienced line workers, managers and other staff.

4.2.2 State Specific Program Goals

The Pollution Prevention Team (or individual) will need to establish specific and well-defined goals that are consistent with the company's pollution prevention policy.

Pollution prevention goals may be qualitative or quantitative. Examples of qualitative goals include "to achieve a significant reduction of toxic substance emissions to the environment", or "to continually strive towards zero-discharge status". Examples of quantitative goals include "to reduce pollution by 10% per year per unit of production", or "to achieve zero-discharge status by the year 2000". The types of pollution to be targeted may be specified in the goals, or the desired reduction.

Benchmarks for emissions should be established in the environmental review process by which results of pollution prevention implementation can be assessed.

Pollution prevention goals should be meaningful and useful. They should be challenging enough to motivate, but not unreasonable or impractical. They should be flexible and adaptable to the changing needs of the pollution prevention program as it develops over time. Pollution prevention goals can be redefined as the pollution prevention program becomes more focused and the pollution-specific aspects of the operation become better known.

Pollution prevention goals should be periodically reviewed and redefined as required. The periodic review will help to keep the program active and visible in the company.

4.2.3 Determine Budget and Schedule

The Program Leader will need to confirm the resources that are available for the effort, and time commitments that management may have established in implementing the program. The resources, time and money that are available for the program will impact on the level of effort for the review and subsequent steps.

4.3 STEP 3: PERFORM ENVIRONMENTAL REVIEW(S)

The steps needed to complete a preliminary and/or detailed environmental review are detailed in Section 5 of this manual. These steps should be followed at this time. As discussed in Section 5, the goals of the environmental review, and the need for a preliminary and/or detailed environmental reviews will vary depending on the company needs and resources.

The Environmental Review Worksheets provided with this manual are designed to be used by either a smaller, less complex operation for a single review process or by a larger, more complex multi-site facility for a multiple review process. For a single review process, the Worksheets would be completed in detail for the facility to be reviewed.

It is important, at this stage, to establish benchmark data based on industry performance in general, regulatory standards or best available technology. Operational performance can be assessed according to benchmark data before and after the implementation phase.

4.4 STEP 4: IDENTIFY POLLUTION PREVENTION OPTIONS

Pollution prevention options may become apparent during the review process, or may be generated after the review process is complete. Developing pollution prevention options requires a combination of genuine creativity and technical know-how. Many creative ideas may have evolved during the environmental review, and other ideas will need to be proposed and explored. It is often worth considering a "brainstorming" session with team members. Brainstorming sessions provide a non-judgemental, synergistic atmosphere which encourages creative thought.

All pollution prevention options should be recorded, and then organized. Options that are true source reduction options should be ranked highest. Source reduction options reduce the amount of waste that is created during processing. They include changing input materials, changing technology, and improving operating practices. Normally, the priority for pollution prevention options, in order, are the following:

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

Some options may reduce pollution by providing additional treatment. Other options may require finding beneficial uses for a waste stream, rather than disposing of the waste stream. These options are valuable in the overall company program but should be ranked lower than true pollution prevention options. Other examples of options which are valuable but ranked lower than true pollution prevention options include waste treatment, off-site recycling, dilution or concentration of pollutants, and transferring of pollutants between phases. These options are ranked lower because the actions are taken after the waste is created as opposed to actions which are taken to prevent the creation of the waste in the first place.

The information contained in Section 6 provides a starting point for option generation. Some of the ideas presented in Section 6 are source control options and some are treatment options. Worksheet #7 includes information for source control options for this industry.

4.5 STEP 5: EVALUATE POLLUTION PREVENTION OPTIONS

It is now necessary to determine which options should be implemented. It may be obvious that some options are easily implemented while other options may require additional evaluation.

Options which reduce pollution, and have no cost or risk, can be implemented immediately. Examples of low-cost options which reduce pollution include improving operating and maintenance procedures, improving housekeeping practices, improving inventory control, and implementing flow/material segregation.

Options which are impractical or provide only marginal value can be dropped.

The remaining options may require a more detailed evaluation to determine which options are technically, environmentally and economically feasible. The evaluation is carried out in much the same manner as an evaluation for any other engineering project, with a few subtle differences. Each option is evaluated for technical, environmental and economic merit. The difference from a usual evaluation approach is the use of Total Cost Analysis during the economic evaluation. Total Cost Analysis provides a method by which to more thoroughly evaluate the costs and/or benefits associated with pollution prevention projects. Some ideas related to the evaluation process for pollution prevention projects are discussed in the following paragraphs.

Published data and information from vendors and engineering consultants can be used to evaluate the technical merits of pollution prevention options. Pilot-scale tests may be required for complex pollution prevention options. A consultant may be hired to design the test program or to aid in the technical evaluation process.

Pollution prevention options should be evaluated for environmental feasibility. For example, does the option actually reduce the toxicity of a waste stream, does the option just transfer the problem to another media, does the option create another waste stream or other environmental impacts, or does the option consume more energy? An engineering or environmental consultant can help to evaluate the environmental impacts and feasibility of pollution prevention projects.

Pollution prevention options will need to be evaluated for economic feasibility. As a minimum, direct costs including capital, operating and revenue, and indirect costs, will need to be determined. Indirect costs include costs associated with administration, regulatory compliance, insurance and Workers' Compensation. Substantial savings in indirect costs can result from pollution prevention projects. Examples include lower administration associated with permits, less regulatory compliance costs and reduced insurance needs.

In addition to the above costs, but more difficult to determine, are intangible costs associated with pollution prevention projects. An example of an intangible cost is the potential cost of continuing the existing operating conditions. This cost is often not readily available or easily predicted.

A Total Cost Analysis approach can be used to help assign true costs to intangible costs and benefits associated with pollution prevention projects. The Total Cost Analysis approach includes assigning costs and/or modifying the economic evaluation approach for intangible items such as costs due to long-term liabilities associated with possible penalties, fines, personal injuries, property damage, site remediation and clean-up costs. The Total Cost Analysis approach also includes assigning benefits due to possible increased sales due to an enhanced company image and consumer trust, increased productivity due to improved employee relationships, improved relationships with suppliers and customers, and/or improved relationships with regulators, all as a result of pollution prevention projects.

An excerpt on total cost accounting is contained in Appendix E to this Manual.

Technical, environmental and economic feasibility studies may be carried out in-house or a consultant may be hired to perform the studies. If a consultant is hired, he/she should work closely with the owner to determine the specific needs regarding indirect and intangible costs.

It may be necessary to summarize the results of the technical, environmental and economic evaluations of the pollution prevention options in an informational letter to management or a more detailed report format. This written information may be required as a basis for evaluating the pollution prevention program, or for securing funding for the selected pollution prevention projects.

4.6 STEP 6: IMPLEMENT POLLUTION PREVENTION PROJECTS

At this point in the program, pollution prevention projects can be selected for implementation. Funding will be required, and may be available in the capital budget for the existing period, or for the following year.

Installation of pollution prevention projects is much the same as for other capital improvement projects. The phases of the project will likely include planning, design, procurement, construction and operator training during start-up. After the project is implemented, it will be necessary to measure the effectiveness of the project. Did the pollution prevention project prevent pollution, how much, and at what cost? A formalized account of the project effectiveness, with direct, indirect and intangible costs and benefits, may be required.

4.7 MAINTAINING THE POLLUTION PREVENTION PROGRAM

The activities described above for the Pollution Prevention Program are also shown in Figure 4.1. The activities shown in the figure are linked to show the normal logical sequence of activities, and also the cyclical nature of the process. Companies that are committed to pollution prevention will repeat the process on a regular basis. The activities, including the environmental review, and developing, evaluating and implementing options, are repeated on an annual or bi-annual basis. This cycle leads to continuous improvement in environmental performance of a company. As the program develops over time, it may also be necessary to step back out of the cycle to redefine the specific pollution prevention goals that were initially targeted.

It is important to maintain the Pollution Prevention Program, and keep employees aware of its existence. This can be done by keeping employees informed, providing training for employees, recognizing employees for their pollution prevention efforts, encouraging employees to participate, and publicizing success stories. The ideas presented below are a summary of methods for accomplishing the task of maintaining a viable pollution prevention program.

- Integrate pollution prevention into corporate planning:
  - Assign pollution prevention accountability to the operating units where waste is generated;
  - Track and report program status; and
  - Conduct an annual program evaluation at the corporate level.
- Provide ongoing staff education programs:
  - Make pollution prevention awareness program a part of new employee orientation;
  - Provide advanced training; and
  - Retrain supervisors and employees.
- Maintain internal communication:
  - Encourage two-way communication between employees and management;
  - Solicit employees' pollution prevention suggestions; and
  - Follow-up on employee suggestions.
- Reward personnel for their success in pollution prevention:
  - Cite accomplishments in performance reviews;
  - Recognize individual and group contributions;
  - Grant material rewards; and
  - Consider pollution prevention a job responsibility subject to review.

- Provide public outreach and education about pollution prevention efforts:

  - Submit press releases on innovations to local media and to industry journals read by prospective clients; and
  - Arrange for employees to speak publicly about pollution prevention measures in schools and civic organizations.

5.0 ENVIRONMENTAL REVIEW PROCEDURES AND WORKSHEETS

5.1 WHAT IS AN ENVIRONMENTAL REVIEW?

An environmental review or audit is an objective, routine review of operations to determine environmental performance with external environmental legislation and internal environmental policies and standards.

The Canadian Standards Association has defined an environmental audit as "a systematic process of objectively obtaining and evaluating evidence regarding a verifiable assertion about an environmental matter, to ascertain the degree of correspondence between the assertion and established criteria, and then communicate the results to the client."

The Canadian Standards Association further defines a verifiable assertion as "a declaration or statement about a specific subject matter which is supported by documented factual data" (CSA, 1994).

Examples of environmental matters which might be the subject of an environmental review could include company policies, operating and other procedures and practices, training, health, safety, waste, conservation, hazardous materials, transportation and emergency response procedures, among others.

Environmental audits require commitment, take time, cost money and may not appear to contribute to the overall financial performance of a company. In the absence of legal requirements to perform an audit, why audit? The environmental audit can help a company to:

- identify whether environmental objectives are being achieved and, if not, why not?;
- identify all measures that could improve environmental performance (pollution control, pollution prevention, alternate products, etc.);
- increase employee awareness of environmental policies and responsibilities;
- improve corporate responsiveness to an emergency;
- protect Officers and Directors from incurring personal liability for corporate environmental responsibility;
- reduce environmental risks, liabilities and exposure to litigation; and
- prove Due Diligence.

5.2 WHY PERFORM AN ENVIRONMENTAL REVIEW?

Environmental reviews may be performed for many reasons. The environmental review process and worksheets included in this chapter are designed to help a processor to do the following:

- determine compliance with external regulations (Compliance Review); and
- determine opportunities where pollution prevention can be implemented that will improve environmental performance (Pollution Prevention Review).

Other types of environmental reviews may include management reviews, procurement reviews, real estate reviews, water conservation reviews, energy conservation reviews, supplier reviews, etc.

The environmental review procedures presented in this manual are simple, objective, and presented in a step-by-step format. They are intended to be followed by plant operators to carry out an unbiased self-review of compliance requirements and pollution prevention opportunities in their facilities.

The review procedures presented in this manual are adapted from the CSA *Guidelines for Environmental Auditing: Statement of Principles and General Practices, 1994*, and the EPA *Facility Pollution Prevention Guide, 1992*. They follow a widely accepted procedure consisting of pre-review, review and post-review steps. The procedures are tailored to perform an environmental review for determining compliance and pollution prevention opportunities, but can be adapted for other needs as required.

5.3 WHEN TO CONDUCT AN ENVIRONMENTAL REVIEW?

The environmental review is only one component of the overall Pollution Prevention Plan as described in Section 4 of this manual. A comprehensive Pollution Prevention Plan contains a planning and organization step, the environmental review step, generation and evaluation of pollution prevention options, and an implementation phase.

For an environmental review to be successful, it should be completed after planning and organization of the Pollution Prevention Program (as described in Section 4) are completed. Environmental reviews are repeated periodically, usually annually or bi-annually. Repeating the environmental reviews leads to a continual improvement in environmental performance of a company.

5.4 STRUCTURE OF ENVIRONMENTAL REVIEWS

Environmental reviews may have many different objectives. They may be conducted in a variety of settings by review teams of varied backgrounds and experience, and with varied budgets and schedules. Even so, environmental reviews typically follow a common set of processes and procedures. A typical environmental review consists of three periodically-repeated phases called the pre-review, site review and post review. This uniform structure allows adequate, accurate coverage of products and operations, and facilitates future repeatability.

Environment Canada *(Pollution Prevention Plans*) and the EPA *(Facility Pollution Prevention Guide)* each recommend that a Preliminary Environmental Review (Preliminary Review) be performed prior to the Detailed Environmental Review (Detailed Review). The Preliminary Review and Detailed Review each follow the phases and steps outlined above; however, the level of detail and commitment of resources and funds is considerably less for the Preliminary Review, as compared to the Detailed Review.

The Preliminary Review is designed to provide a focus for consideration of pollution prevention, thereby reducing the amount of data collection and analysis/evaluation costs associated with the Detailed Review. During the Preliminary Review, all waste streams and associated costs of treatment and disposal are identified. Areas where costs are high, or where quantities of waste are high, may be targeted for further consideration in the Detailed Review. The Preliminary Review, therefore, acts as a screening device so that areas of opportunity for pollution prevention can be identified and prioritized. The Detailed Review then concentrates on the high priority areas only.

Each of the activities of the environmental review is discussed in detail in the following sections. The degree of formality and the number of environmental reviews should be tailored to the size of the company, the company's needs and the diversity of its product lines. For example, a smaller company may need to do only one review and, subsequently, prepare one implementation plan. Larger, more diverse companies may need to carry out the preliminary review and several detailed reviews in order to address all production processes. If multiple reviews are carried out, it is necessary to co-ordinate them to fit available resources and avoid duplication.

Many of the fruit and vegetable processing operations in the lower Fraser Valley are small operations with limited resources. The employee(s) responsible for developing the Pollution Prevention Plan should familiarize themselves with the material in this section. During the Preliminary Review, enough data should be collected in order to prioritize areas, and then pollution prevention options should be developed and implemented. Employees in larger companies will want to consider carrying out a preliminary review in order to prioritize areas, followed by a detailed review(s) for selected areas only.

The steps to complete a preliminary review and a detailed review are described in the following sections. The preliminary review is a shortened version of the detailed review, less formal, and less costly. The employee in charge of the program for the company may wish to incorporate items contained in the detailed review procedure in the preliminary procedure, depending on the company's unique situation.

A set of blank worksheets is contained in Appendix F. The worksheets are intended to simplify the entire Pollution Prevention Planning Program and, as such, the Appendix includes worksheets for the activities described in Section 4, as well as the Environmental Review Procedures below. For each task or activity, the corresponding worksheet is referenced.

5.5 PRELIMINARY ENVIRONMENTAL REVIEW

Objectives:

- Determine compliance of facility with current regulations.
- Determine areas of opportunity for pollution prevention and assign priorities.

Summary of Tasks:

1. Pre-Review:
   - Organizational Activities (Worksheets #1, 2)
   - Collect Background Data (Begin Worksheets #3,4,5,6)
2. Site Review:
   - Visit Site(s) (Complete Worksheet #3,4,5)
3. Post Review:
   - Determine Compliance (Complete Worksheet #6)
   - Assign Priorities (Complete Worksheet #6)

5.5.1 Pre-Review Activities

Organizational Activities (Worksheet #1, #2)

For the preliminary review, the extent to which organizational activities take place will depend on the needs of the company and the available resources. Examples of organizational activities include determining what facilities will be reviewed, who will carry out the review, when and how it will happen, and communicating and discussing the benefits of pollution prevention with participants. These activities are discussed in greater detail in Section 5.6.1. Worksheets #1 and #2 are guidelines of organizational activities that will help reduce costs associated with the Preliminary Environmental Review and increase its success. Figures 1 and 2 are examples of Worsheets 1 and 2 completed for a fictitious raspberry processing operation.

Pollution Prevention **Worksheet 1**
Fruit & Vegetable Processors

Initial Activities

Company:	ABC PROCESSORS	**Prepared by:**	PJ
Location:	ABBOTSFORD	**Date:**	96-01-15
Process Area:		**Sheet** 1 **of** 9 **Page** 1 **of** 1	
Notes:	RASPBERRY PROCESS LINES		

Activity	Status			
	Complete? (Y/N)	Current? (Y/N)	Last Done	Notes
1. Secure Management Commitment	Y			
. Is Board of Directors involved?	Y			
. Is Board of Directors supportive?	Y			
2. Define Policy Statement	Y			
. Why?	Y			
. What?	Y			
. Who?	Y			
3. Develop Employee Awareness				
. Circulate policy statement	Y			
. Communicate P2 concept	Y			
. Use newsletter	N/K			
. Involve/Motivate employees	Y			
. Educate employees				
. Include P2 in new employee orientations		N		PLANNED
. Compensate/reward employees		N		UNDER REVIEW
4. Establish P2 Team				
. Representation from different departments?	Y			
. Mix of technical, financial management & communication	Y			
. Team leader?	Y			TOM
. Resources?	Y			500 HRS
5. Establish P2 Goals - Are goals:				
. specific, well defined?				UNDER REVIEW
. clearly stated?	Y			
. meaningful & useful?	Y			
. quantitative/qualitative?	Y			
. challenging?	Y			
6. Establish Schedule & Budget				
. Are resources available? (people, time & money)	Y			$20,000

Figure 5.1 Worksheet 1 - Initial Activities

Pollution Prevention **Worksheet 2**

Fruit and Vegetable Processors

Pre-Review Activities

Company:	ABC PROCESSORS	**Prepared by:**	AJ
Location:	ABBOTSFORD	**Date:**	96-01-15
Process Area:	RASPBERRY PROCESS LINES	**Sheet** 2 **of** 9	**Page** 1 **of** 1

Description/Notes:

Activity	Status		
	Complete? (Y/N)	Date	Notes
1. Perform Preliminary Environmental Review			
. Determine sites? locations?	N	07-15	COMMENCE REVIEW
. Determine priorities?	Y		-WATER FLOWS
. Determine areas of focus?	Y		-QUALITY OF PRODUCT
2. Select Facility, Sites, or Process Area			
. For Environmental Review	Y	07-15	PROCESSING AREA
3. Select the Review Team			
. Multidisciplinary	Y		
. Commitment to program	Y		
. Team players	Y		
. Creative thinkers	Y		
4. Plan the Site Review			
. Agenda	Y		
. Schedule	Y		
. Availability of personnel	Y		
. Resource needs (camera, sampling, etc.)	Y		
. Orientation tour	Y		
. Responsibilities of review team members	Y		
5. Collect Background Information			
. Worksheets #3	N		-TO BE COMPLETED
. Worksheets #4	N		"
. Worksheets #5	N		"
. Worksheets #6	N		"

Figure 5.2 Worksheet 2 - Pre-Review Activities

Collect Background Data (Worksheets #3, 4, 5, 6)

The extent and complexity of the system for collecting pollution prevention data should be consistent with the needs of your company. The goal of the program is to prevent pollution, not to collect data. The simplest system that fits your needs is the best. Depending on the nature and size of your firm, much of the data needed for a pollution prevention program may be collected as a normal part of plant operations, or in response to existing regulatory requirements.

For smaller facilities with limited waste streams and/or limited process modification options, collecting background data 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.

For the fruit and vegetable processing industry, feedstock and product varies in the season depending on the crop processed. The worksheets have been tailored to meet the need for waste data specific to each crop.

In general, background data should be collected for all media, i.e. air, water and solid residuals. This involves considering all waste streams, identifying their sources and quantifying the true costs of pollution control, treatment and/or disposal. The major sources of pollution from the fruit and vegetable processing industry have already been determined to be associated with the wastewater stream and solid waste stream (see Section 3). Therefore, background data should be collected for these two types of waste streams only.

The table below contains a list of sources of information for carrying out an environmental review.

DATA SOURCES FOR BACKGROUND INFORMATION INCLUDE:

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 (Environment Canada, BCMOELP, GVRD)

Process Information:

- Process flow diagrams
- Design an actual material and heat balances for:
  - production processes
  - pollution control processes
- Operating manuals and process descriptions
- Equipment lists
- Equipment specifications and data sheets
- Piping and instrument diagrams
- Site and elevation plans
- Equipment layouts and logistics

Raw Material/Production Information:

- Product composition and batch sheets
- Material application diagrams
- Material safety 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 (i.e.,: trash and scrap metal)
- Product, energy and raw material costs
- Operating and maintenance costs
- Revenue

Other Information:

- Environmental policy statements
- Standard procedures
- Organization charts

5.5.2 On Site Activities (Complete Worksheets #3, 4, 5, Continue #6)

The site visit is used to review the accuracy of the background information collected and to identify missing or poorly documented information.

The site visit should be well-planned and conducted to ensure that maximum benefit is obtained. Although most of the following suggestions are common sense, they are mentioned here as a reminder for planning and conducting a successful site visit:

Pollution Prevention **Worksheet 3**

Fruit and Vegetable Processors

Process Information

Company: ABC PROCESSORS	Prepared by: PJ
Location: ABBOTSFORD	Date: 96-01-15
Process Area: RASPBERRY PROCESS LINES	Sheet 3 of 9 Page 1 of 1

Description/Notes:

Type of Operation:

✓ Continuous ___ Discrete ___ Batch/Semi-Batch ___ Other(Specify)

Document	Status: Complete? (Y/N)	Current? (Y/N)	Last Revision	Document Number	Location
1. Process Flow Diagram(s)	N				
2. Material/Energy Balance					
Design	N				
Operating	N				
3. Flow/Quantity Measurements					
Feed Stream(s)	Y	Y	95-08		
Product Stream(s)	Y	Y	95-08		OFFICE
Residual Stream(s)	Y	Y	" "		"
Effluent Stream(s)	Y	Y	" "		"
4. Analytical Data & Documentation of Methods					
Feed Streams	N				
Product Stream(s)	N				
Residual Stream(s)	Y	Y	95-08		OFFICE
Effluent Stream(s)	Y	Y	"		"
5. Process Description					
Operating Manuals	Y	Y			OFFICE
Equipment List	Y	Y			"
Equipment Specifications	Y	Y			"
Piping and Instrument Diagram(s)	N				
6. Layout/Elevation Plan(s)					
Work Flow Diagrams	Y	Y	95-09		OFFICE
Hazardous Waste Manifests	Y	Y	95-12		
Emission Inventories	N				
Environmental Audit Reports	N				
7. Permit/Permit Applications					
Material Safety Data Sheets	Y	Y	95-12		OFFICE
Inventory Records	Y	Y	"		
Operator Logs	N				
Production Schedules	Y	Y	95-08		"
Other:					
Other:					
Other:					

Figure 5.3 Worksheet 3 - Process Information

Pollution Prevention **Worksheet 4**

Fruit and Vegetable Processors

Stream Mass Flow Data Sheet

Company: ABC PROCESSORS	Prepared by: PJ
Location: ABBOTSFORD	Date: 96-01-15
Process Area:	Sheet 4 of 9 Page 1 of 1
Product: RASPBERRIES / IQF	Description/Notes:
Type of Operation: √ Continuous __ Discrete Batch/Semi-Batch Other (Specify)	
Reference Process Flow Drawing(s): PFD # N Date ____	

Stream No:	1 - Process														
Stream Name:	Wash														
Description:	- Clean product														
Duration:	- Cont														
Identify Waste (Waste):	- Wash eff.														
Phase (Solid(S), Liquid(L) or Gas(G))	S/L														
Stream Data:	min.	norm.	max.	min.	norm.	max.	min.	norm.	max.	min.	norm.	max.	min.	norm.	max.
Total Flow (kg/hr):	2500	5000	7000												
Product (kg/hr):															
Dry Ingredient (kg/hr):															
Dry Ingredient (kg/hr):															
Wet Ingredient (Oil) (kg/hr):															
Wet Ingredient (kg/hr):															
Other (kg/hr):															
Other (kg/hr):															
Waste Product (kg/hr):															
Water (kg/hr):	2500	5000	7000												
TSS (kg/hr):		0.5													
BOD (kg/hr):		1.5													
COD (kg/hr):		0.3													
O&G (kg/hr):		0.05													
Cleaning Agents (kg/hr):															
Sodium Hypochlorite (kg/hr)		4.0										(ON CLEANUP)			
Detergent (kg/hr):		N													
Other (kg/hr):		N													
Physical:															
pH:		6.0													
T (deg.C):		15													
P (kPa(g)):															
Size:															
Operating:															
Operating Hours/Day:		12													
Operating Days/Year:		60													

Figure 5.4 Worksheet 4 - Stream Mass Flow Data Sheet

Pollution Prevention **Worksheet 5**

Fruit & Vegetable Processors

Transport/Financial Information

Company: ABC PROCESSORS	Prepared by: RJ
Location: ABBOTSFORD	Date: 96-01-15
Process Area: RASPBERRY PROCESSING LINES	Sheet 5 of 9 Page 1 of 1

Description/Notes/Reference Drawings:

Type of Operation:

✓Continuous ___Discrete ___Batch/Semi-Batch ___Other(Specify)

Stream No.:	1-PROCESS		
1. Stream Data:			
Stream Name:	RESIDUAL		
Description:			
Feed(F)/Product(P)			
Phase (Solid(S), Liquid(L), Gas(G))	S		
2. Flow Data:			
Stream Hourly Flow (kg/hr)	250		
Operating Hours/Day	12		
Operating Days/Year	60		
Stream Yearly Flow (tonne/year)	180		
3. Financial:			
Unit <Cost>/Revenue $/tonne	<$70>		
Annual <Cost>/Revenue $/year	<$12,600>		
4. Transportation/Handling:			
Shipping Mode (truck, etc.)	TRUCK		
Shipping Container Type			
Size (Bag, Box, etc.)	BULK		
Storage Mode (Outdoor, Warehouse, etc.)			
Transfer Mode (Forklift, Conveyor, etc.)			
Cost of transportation ($/year):	<$2,700>		
5. Input Materials Summary:			
Supplier would:			
- accept expired material? (Y/N)	N		
- accept shipping containers? (Y/N)	N		
6. Products Summary:			
Are Containers Returnable? (Y/N)	N/A		
Customer Would:			
- accept expired material? (Y/N)			
- accept shipping containers? (Y/N)			
- relax specification? (Y/N)			
- accept larger containers? (Y/N)			

Figure 5.5 Worksheet 5 - Transport/Financial Information

Pollution Prevention **Worksheet 6**

Fruit & Vegetable Processors

Waste Stream - Compliance / Prioritization

Company: ABC PROCESSORS	Prepared by: PJ
Location: ABBOTSFORD	Date: 96-01-16
Process Area: RASPBERRY PROCESS LINES	Sheet 6 of 9 Page 1 of 1
Notes:	Reference Drawings:
	Type of Operation: ✓ Continuous ___ Discrete ___ Batch/Semi-Batch ___ Other (Specify)

Stream No.:						
1. Waste Stream Data:						
Stream Name: LIQUID EFFLUENT						
Description:						
Phase (Solids(S), Liquid(L)):						
2. Quantity Data:		Normal	Permit	Normal	Permit	Normal	Permit
Volume Flow (m3/d)		60	100	15			
Mass Flow (kg/d)							
BOD (mg/L)		300	300	15			
BOD (kg/tonne product)		0.3	/	15			
TSS (mg/L)		100	100	15			
TSS (kg/tonne product)		0.1	-	15			
pH		6.0	5.5/10.0	15			
Other:							
Other:							
Other:							
3. Disposal Information:							
Disposal/Discharge Method:		CITY SEWER		CITY SEWER			
Permitted by:		ABBOTSFORD		ABBOTSFORD			
Unit Cost ($/kg or m3)							
Yearly Cost ($/ year)		$35,000		$8,750			
	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
4. Priority Rating Criteria (see Note)							
Regulatory Compliance	10	8	80	8	80		
Treatment/Disposal Cost	10	9	90	10	100		
Potential Liability	5	4	20	3	15		
Waste Quantity Generated	7	3	21	2	14		
Waste Hazard	5	2	10	5	25		
Safety Hazard	10	2	20	5	50		
Minimization Potential	5	6	30	10	50		
Potential to Remove Bottleneck	10	5	50	5	50		
Potential By-product Recovery	5	1	5	1	5		
Sum of Priority Rating			306		389		
Priority Rank		2		1			

Note: Assign relative weights (W) to criteria depending on importance and then rate (R) each stream in each category on a scale from 0 (none) to 10 (high).

Figure 5.6 Worksheet 6 - Waste Stream - Compliance Prioritization

Planning:

- confirm who will participate and their availability;
- confirm time of site visit(s) and ensure it is appropriate to facility operation;
- prepare a site inspection agenda, and pass out to participants ;
- discuss the review program with staff in the areas being reviewed;
- review the existing documentation prior to the visit; and
- pre-determine a data collection format.

Conducting:

- conduct a kick-off meeting to start the review;
- interview operators and supervisors;
- take notes, pictures, observe and assess operations as needed;
- follow the process from beginning to end; and
- conduct a closing meeting to end the review.

The results of the site visit are used to update the mass balances and process flow diagrams and to finalize collection of all the data.

5.5.3 Post Review Activities

Determine Compliance (Worksheet #6)

One goal of the Preliminary Review is to determine compliance with local regulations.

The Ministry of Environment report on *Pollution Control Objectives for Food-processing, Agriculturally Oriented, or other Miscellaneous Industries of British Columbia*, provides information on effluent limitations for fruit and vegetable processors. This information was summarized in Section 3, and is included in Worksheet #6.

The data collected during the previous two steps are now compared to the guidelines in the worksheet to determine if the facility is likely to be in compliance with current regulations.

Establish Priorities (Worksheet #6)

The final step in the Preliminary Review is to assign priorities to processes, operations and materials which have high potential for pollution prevention. The priorities set during this task will guide the selection of areas for pollution prevention option generation or further detailed assessments. Areas may be prioritized based on a number of criteria. The following list provides typical considerations for prioritizing waste streams for further study:

- compliance with current and anticipated regulations
- costs of waste management (pollution control, treatment and disposal)
- potential environmental and safety liability
- quantity of waste
- hazardous properties (toxicity, flammability, corrosivity and reactivity)
- safety hazards to employees
- potential for pollution prevention
- potential for removing bottlenecks in productions or waste treatment
- potential recovery of valuable by-products
- available budget for pollution prevention assessment program and projects
- minimizing waste water discharges
- reducing energy use

An Option Rating Weighted Sum Method is included on Worksheet #6 and can be used to assign priorities.

5.6 DETAILED ENVIRONMENTAL REVIEW

The Detailed Review is intended to be voluntary and self-administered by facility personnel. For small companies, the detailed review team may be the same as for the previous preliminary review. For larger companies, more staff may need to be assigned, and more than one review team may be required. In general, three to six people is usually a workable number for a review team. Specialists can be consulted as needed.

Objective:

Collect additional data and delve more deeply into the production process for those specific areas that were targeted by the Preliminary Review.

Summary of Steps:

1. Pre-Review:
   - Select Review Team Members (Worksheet #2)
   - Plan the Review (Worksheet #2)
   - Obtain Background Information (Worksheets #3,4,5,6)

2. Site Review:
   - Opening Activities
   - Collect Data (Complete Worksheets #3,4,5,6,7)
   - Evaluate Data
   - Closing Activities

3. Post Review:
   - Issue Report
   - Prepare Action Plan

The detailed environmental review is a more detailed and formalized review procedure when compared to the preliminary review. It may involve more participants, require more resources and take longer to complete.

5.6.1 Pre-Review Activities

Pre-review activities include activities preparatory to the site visit. These activities include selecting and contacting review team members, assigning responsibilities, establishing lines of communication, planning and organizing the site visit, determining reporting needs and reviewing background information.

Select Review Team Members (Worksheet #2)

A multidisciplinary team is likely to be more successful in achieving a comprehensive review and providing the best input possible to the data analysis and option definition stages. To the extent practicable, consider engineers, supervisors and production workers, as well as finance and accounting, purchasing and administrative staff when selecting the team members.

Aside from field expertise, team members should be chosen for their ability to work on a team, apparent interest in and commitment to the program, capacity for looking at situations from new perspectives and ability to think creatively.

A typical review team for a small fruit or vegetable processing facility would include:

Review Team:

- Production Supervisor - Team Leader
- Environmental or Production Engineer
- Maintenance Engineer

In the above case, the team leader is the production supervisor. This person has day-to-day operations responsibility and experience.

The focus of the review team should be defined and specific. The responsibilities for each review team member should be assigned at this stage.

Plan the Review (Worksheet #2)

Site reviews should be well-planned to ensure success. The planning steps outlined below should be undertaken at this point. Good planning will reduce the need for additional site visits to check or supplement data.

Prepare an agenda, in advance, that covers all points that still require clarification. Provide staff contacts in the area being assessed with the agenda several days before the site visit.

Schedule the site visit to coincide with the particular operation that is of interest (e.g., washing, blanching, cooling, clean-up, etc.)

Plan to monitor the operation at different times during shifts and, if needed, during all shifts, especially when waste generation is highly dependent on human involvement (e.g., during cleaning operations).

Confirm the availability of team members.

Discuss the review program with staff in the areas being assessed.

Determine resource needs (laboratory, sampling, photographic equipment, etc.).

Obtain Background Information (Worksheets #3,4,5,6)

Documentation that was collected during the Preliminary Review and other pertinent background information for the prioritized areas should be gathered in one place and organized. Additional information that is available, but was not previously collected, should also be collected at this time. This information will be used by the team to help focus on the priority areas.

5.6.2 Site Review Activities

Most of the effort here is directed towards performing a thorough site review and interviewing workers. Data collected during the site review supplements and explains existing data. The site review step consists of opening activities, data collection activities, organizing and evaluating the data, and closing activities.

Opening Activities

The site review should commence with an opening meeting. The team members will review background information, review the upcoming activities and confirm their understanding of responsibilities, processes and lines of communication.

An orientation tour of the facility may be required for team members not familiar with the site.

Collect Data (Worksheets #3, 4, 5, 6)

During the site review, information will be collected using the following techniques:

Photograph or videotape the area of interest, if warranted. Pictures are valuable in the absence of plant layout drawings. Many details can be captured in pictures that otherwise could be forgotten or inaccurately recalled at a later date.

Observe the "housekeeping" aspects of the operation. Check for signs of spills or leaks. Visit the maintenance shop and ask about problems in keeping the equipment leak-free. Assess the overall cleanliness of the site. Pay attention to odours and fumes.

Assess the organizational structure and level of co-ordination of environmental activities between various departments.

Assess administrative controls, such as cost accounting procedures, material purchasing procedures and waste collection procedures.

Observe operations as they are actually performed by different shifts and under various circumstances. Process units may be operated differently from methods described in their operating manuals, or the equipment may have been modified without being so documented in the flow diagrams or equipment lists.

Interview workers and supervisors to determine how aware they are of what wastes are generated by their operation. They may have suggestions on reducing these wastes.

Follow the process from beginning to end, from the point where input materials enter the work-site to the point where products and wastes exit. This will help identify all suspected sources of waste. Waste sources to inspect include the production process; piping; maintenance operations; storage areas for raw materials, finished product and work-in-process. Examine housekeeping practices and the waste treatment area, as well.

Make follow-up visits as missing or unclear data are identified during the analysis stage.

The site review should not be performed superficially, even though the assessment team members will all be familiar, to some extent, with the work-site being reviewed. Those who are not involved in the day-to-day operation in that area will see factors that otherwise would be overlooked. Furthermore, personnel assigned to that specific site will often see it in a new light when performing a pollution prevention assessment.

Organize, Document and Evaluate Data

Analyzing process information requires preparing material and energy balances to determine pollution sources. The material and energy balance is an organized system of accounting for the flow of mass and energy in a process. In a simple form, the material balance for any specific material is:

$$\text{Mass In} = \text{Mass Out}$$

Pollution Prevention **Worksheet 7**

Fruit & Vegetable Processors

Option Generation

Company: ABC PROCESSORS	**Prepared by:** RJ
Location: ABBOTSFORD	**Date:** 96-01-20
Process Area: RASPBERRY PROCESS LINES	**Sheet** 7 **of** 9
Notes:	**Meeting Format:** ROUND-ROBIN
	Meeting Coordinator: TOM
	Meeting Participants: TAM, RJ, DAS, JWW, PAB

List Suggested Options	Rationale/Remarks on Option	Action
* List is not exhaustive and may be used as a guide to prompt other options *	Currently Done Y/N	
1. Raw product washing		
First wash followed by second wash	N	DON'T DO
Final wash		
Countercurrent with water treatment	N	FRESH WATER ONLY
2. Fluming		
Fluming of un-washed product	N	
Fluming of prepared product	N	
Fluming of solid residuals	N	
3. Blanching		
IQB blanching	N	
Steam blanching	N	
Replacement of make-up water	N	
4. Washing totes, flats, trays, etc.		
Tank washers & recycled, treated water	Y	
Spray with make-up water	Y	
5. Cooling water		
Countercurrent cooling	N	
Cooling water to wash line	N	
6. Plant sanitation		
Preliminary dry pick-up	Y	IMPROVED TECHNIQUE, TRAINING REQ'D.
Preliminary wash-down with recycled water		
7. Mechanical systems		
Compressor cooling water recycle	N	CALL IN CONTRACTOR
Packaging machine cooling water recycle	N	
8. Other Options		

Figure 5.7 Worksheet 7 - Option Generation

Pollution Prevention **Worksheet 8**

Fruit & Vegetable Processors

Option Description and Economic Analysis

Company: ABC PROCESSORS	**Prepared by:** PJ
Location: ABBOTSFORD	**Date:** 96-01-10
Process Area: RASPBERRY PROCESS LINES	**Sheet** 8 **of** 9
Notes:	**Meeting Format:** ROUND-ROBIN
	Meeting Coordinator: PJ
	Meeting Participants: TAM, DAS, PJ, TWW, PAB

Option Description	Cost Analysis	
DRY PICK-UP	**Capital Costs**	
	Purchased Equipment – HP WASH SYSTEM	12,000
	Materials	
	Installation	3,500
	Utility connections	
	Engineering	
	Start-up and training	1,500
	Other	
	Total Capital Costs, C:	17,000
	Incremental Annual Operating Costs	
SEWER CHARGES	Change in disposal costs	3,200
WATER CHARGES	Change in utility cost	750
	Change in raw material cost	
	Change in labour cost	<5,000>
CHLORINATION	Change in other costs	1,500
	Annual Net Operating Cost Savings, S:	450
	Simple payback period (in years), C/S:	38
	Total Cost Analysis Approach	
	Long-term liabilities	1,000
	Fines	500
	Penalties	
	Personal damages	
	Property damage	
	Site remediation	
	Clean-up costs	
	Enhanced corporate image	6,000
	Marketing benefits	
	Improved relationships in community	500
	Improved employee morale and performance	1,000
	Other indirect benefits	500

Figure 5.8 Worksheet 8 - Option Description and Economic Analysis

Mass and energy balances are usually recorded on a process flow diagram, similar to the process flow diagrams contained in Section 2. The mass balance will show where waste streams are generated.

Similar mass balances can be developed for unit operations or process lines. Multiple mass balances will be required in the fruit and vegetable processing industry due to the number of multiple products. For this industry, a mass balance should be performed for each commodity.

Mass balances are useful for organizing and extending pollution prevention data and should be used whenever possible. However, users should recognize that there are some limitations.

- Some processes may have numerous process streams, many of which affect various environmental media.

- The exact composition of some streams may be unknown and not easily analyzed.

- Many sites lack sufficient historical data to characterize all streams.

Despite the limitations, mass balances are essential to organize data, identify gaps and permit estimation of missing information. They can help calculate concentrations of waste constituents where quantitative composition data are limited. They are particularly useful if there are points in the production process where it is difficult or uneconomical to collect or analyze samples. Data collection problems, such as an inaccurate reading or an unmeasured release, can be revealed when "mass in" fails to equal "mass out." Such an imbalance can also indicate that fugitive emissions are occurring.

Closing Activities

After all the data is organized and compiled, the data should be summarized and presented to the team members and other personnel at a Closing Meeting.

The findings should be discussed and reviewed with plant personnel prior to preparing a report or developing an action plan.

5.6.3 Post Review

Following the site review, two important activities remain, the preparation of the final report and the development of an action plan.

Prepare and Issue Report

The preparation of a final report usually involves the preparation of a draft report to be reviewed and commented on for accuracy. The team leader is usually responsible for preparation of the final report.

Environmental review reports are usually presented in two parts:

- a formal statement of the company's current compliance with legal or corporate standards which includes an inventory and review of in-house programs; and

- a summary of a program of future actions to more fully comply with legal or company standards, or to create or capture new business opportunities.

Prepare Action Plan

The preparation and implementation of a plan and program of action to address problems or opportunities identified in the audit is usually the final and most important step in the audit process. This plan should be developed, approved and implemented as quickly as possible. The action plan should be viewed by management as the culmination and ultimate goal of the environmental review process, rather than an afterthought following the collection of a lot of data. Procedures for monitoring progress (against specific goals or standards) should be developed and enforcement incentives specified. A follow-up to assure the action plan is implemented may be done by the audit team, an internal team of experts or by management.

Pollution Prevention **Worksheet 9**

Remaining Activities

Company: ABC PROCESSORS	**Prepared by:** PJ
Location: ABBOTSFORD	**Date:** 96-01-20
Process Area: N/A	**Sheet** 9 **of** 9 **Page** 1 **of** 1

Activity	Status			
	Complete? (Y/N)	Current? (Y/N)	Last Done	Notes
1. Collect Necessary Data				
. Preliminary review?	Y			
. Detailed review?	Y			
2. Confirm Compliance/Priorities				
. Is facility in compliance?	Y			
. Are waste streams prioritized for further review or P2 option?	Y			
3. Identify P2 Opportunities				
. Best management practices	Y			
. Reduce, reuse, recycle	Y			
. Best available technology	N			NOT REQUIRED.
. Conservation	Y			
. Equipment, operations, procedures	Y			DRY PICK-UP.
. Process changes, material, substitution	N			
4. Evaluate P2 Opportunities				
. Technical	Y			
. Environmental	Y			
. Economic (capital, operating)	Y			
5. Implement P2 Opportunities				
. Select projects	Y			DRY PICK-UP.
. Obtain funding	Y			
. Install				
6. Measure Progress				
. Aquire data				
. Analyze results				
7. Maintain and Improve P2				
. Review program annually or bi-annually				
. Revise as required				
. Repeat annually or bi-annually				
. Integrate with corporate planning				
. Provide ongoing employee education				
. Maintain internal communication				

Figure 5.9 Worksheet 9 - Remaining Activities

6.0 POLLUTION PREVENTION AND CONTROL OPTIONS

This section contains information related to best available technologies and best management practices currently available for preventing pollution and controlling pollution in the fruit and vegetable processing industry. The information included is intended as reference material and, therefore, extends beyond those technologies and practices currently employed in the lower Fraser Valley. The section addresses available technologies and management practices for treating wastewater, reducing water consumption, utilizing solid wastes and reducing cleaning wastes.

6.1 POLLUTION PREVENTION

6.1.1 Introduction

The following list includes the fundamental processes for fruit and vegetable processing facilities:

(a) washing;
(b) sorting and sizing;
(c) blanching, cooling and processing;
(d) packaging; and
(e) shipping or storing.

These processes use several techniques common to manufacturing and other techniques developed exclusively for this industry. The processes used in the fruit and vegetable processing industry are oriented towards providing marketable products throughout the year.

6.1.2 Common Waste Streams

Typical waste streams from this industry include large volumes of solid wastes and process wastewaters containing organic matter, suspended solids and sanitizing chemicals. In addition to conventional waste streams, the industry also generates waste streams from:

(a) cleaning;
(b) sanitizing;
(c) equipment maintenance;
(d) packaging;
(e) printing; and
(f) laboratory analysis.

6.1.3 Special Waste Designation

The processing chemicals used in this industry are not typically designated as Special Wastes in the dilute forms they are used. Exceptions to this are addressed in this document under "Hazardous Substances" and "Hazardous Wastes.@ If the chemicals were discarded in a concentrated form, many of them would be designated as Special Wastes. It is important to note that purposely diluting wastes to change the designation from Special Waste to non-Special Waste is illegal.

6.1.4 Pollution Prevention Opportunities

Historically, resources have been used on a once-through basis and sent off for treatment or disposal. The cost of chemicals, energy, water and disposal are significant. There are a number of cost reductions and recycling opportunities in this industry. They include the following:

(a) recycling "non-contact" and wastewaters;
(b) upgrading existing refrigeration systems (ammonia);
(c) replacing existing refrigeration systems with new, more advanced systems;
(d) ink and solvent substitution for printing processes;
(e) maintenance shop waste reduction opportunities;
(f) energy savings; and
(g) reduction of environmental fee costs (i.e., wastewater discharge permitting fees).

6.1.5 General Recommendations

1. Clearly identify and properly label all chemicals and waste containers. Keep containers closed, except when adding to or removing the contents.

2. Isolate liquid wastes from solid wastes. Never mix different types of waste together. Mixing wastes may make recycling impossible, or make waste disposal much more expensive. If non-hazardous waste becomes contaminated with a hazardous waste, it may need to be disposed of as a hazardous waste. Wastes can be recycled only if they have been kept segregated.

3. Minimize the amount of each waste being generated at its source by identifying where hazardous materials are used and determining the best source reduction method. Substitute less hazardous or non-hazardous substances for hazardous substances whenever possible.

4. Recycle all wastes where practical. Identify the source of all recyclable materials, then provide conveniently located containers for these recyclables.

5. Tighten inventory control. Inventory all substances. Rotate stock to reduce chances of outdated material. Avoid over-purchasing by instituting "just-in-time" purchasing. The benefits include less waste, more efficient supply procedures and ready access to stored goods. Weigh these benefits against potential cost savings with bulk purchases.

6. Provide employee training in hazardous materials management and waste minimization. This will reduce the likelihood of excess waste being generated and increase employee safety.

7. Implement a facility-wide waste reduction program. Form a waste reduction team to conduct annual waste audits.

8. Apportion waste management costs to the departments that generate the wastes. Allow disposal savings from the waste reduction/recycling programs to be used to support the waste reduction/recycling effort.

6.1.6 Wastewater Reduction and Recycling Opportunities

Our survey of the industry in the lower Fraser Valley revealed that there is virtually no significant recycling of wastewater occurring in local plants. This is confirmed in discussions with plant operators and officials at Agriculture and Agri-Food Canada. In fact, there is no policy that provides for recycling in the regulations. The regulations state clearly that potable water must be used in processing plants (Sec. 14.1[i]) and that the only exceptions to the use of potable water will be for use for fire protection, boilers and auxiliary services (Sec. 14.2).

In other jurisdictions, particularly where fruit and vegetable processing is heavily concentrated and processing plants have greater capacity, water recycling accounts for 50 to 70% of the total process water. It is found that recycling and water treatment for the recycled stream are cost effective.

According to the literature, it remains unclear, however, what the long-range effects of recycling on the healthful qualities of the produce and what the impact on public health may be. Generally, chlorination of the recycled water stream is used to control bacteria in the water. The effect of the formation of organic chlorine compounds is not known even if the bacteria count is effectively controlled.

At this time, chlorine treatment is generally regarded as safe (GRAS). However, the methodology is being called into question. There is great seasonal variation on water quality and flows according to the products processed, which causes varying demands on the water treatment system, which results in variable and

unpredictable water quality in the recycle stream. The only parameters that can be monitored on-line are turbidity and chlorine residual which are insufficient to determine actual water quality.

In the industry in the USA, the state of recycling is summarized as follows:

- Generally regarded as unacceptable practice (GRAUP) - once-through washing or cooling since many agriculturally productive regions in the US are short of water and the resource is costly.

- Generally regarded as acceptable practice (GRAAP) - counterflow recycling, modular recycling at unit operations and combination recycling.

- Generally regarded as unacceptable practice (GRAUP) - direct water reuse without treatment.

The policy developed, and generally adhered to in the US, was developed jointly with USDA, USEPA and the National Food Processors Association (NFPA):

> Raw materials shall be washed or cleaned to remove soil or other contamination. Water used for washing, rinsing or conveying food products shall be of adequate quality and water shall not be reused for washing, rinsing or conveying products in a manner that may result in contamination of food products.

The practice of water recycling is prevalent in the US primarily for economic reasons relating to the cost and scarcity of water and less for the control of effluent. Adopting the practice in BC is not recommended unless the processor works closely with Agriculture and Agri-Food Canada.

The following list of opportunities can be considered for adoption in BC processing plants:

(a) Set water conservation goals.
(b) Make water conservation a management priority.
(c) Install water meters and monitor water use.
(d) Train employees how to use water efficiently.
(e) Use automatic shut-off nozzles on all water hoses.
(f) Use high pressure, low volume spray washes during clean-up to conserve water.
(g) Eliminate once-through cooling water usage, by recycling or reuse, whenever possible.
(h) Minimize spilling ingredients and product on floors; always clean up spills before washing.

(i) Cover or decommission old drains leading to the surface waters, dry wells or drainfields.
(j) Don't allow water to run continuously unless necessary.
(k) Use dry (waterless) cleaning methods prior to water clean-up. Don't let people use water as a broom.
(l) Survey system for leaks and repair. Heat exchangers and other "non-contact" water systemsm, in particular, need to be inspected routinely. Conductivity or pH monitors on cooling lines can positively detect leaks.
(m) Use automatic controls to keep cooling waters in correct temperature range.
(n) Install lockout valves to set and ensure proper process water flow levels to prevent valves from being opened wide.
(o) Segregate wastewater streams according to level and type of contamination, and investigate the potential for recovery.
(p) Keep stormwaters out of wastewater. Manage stormwaters separately.
(q) Reuse process waters to clean equipment when feasible.
(r) Filter process and cleaning water to remove particulates; reuse the water.
(s) Use compressed air to clean equipment or parts when appropriate.
(t) Clean with steam to reduce the volume of water used for cleaning.
(u) Use a cooling tower or reuse cooling water to conserve water.
(v) Use process water to wash trucks.
(w) Investigate the applicability of filtering and reusing washwaters for the same process; and investigate the applicability of reusing rinse water as make-up for washwater.

6.1.7 Stormwater Control

The prevention of pollution can also be accomplished by giving careful attention to how stormwater flows through the exterior areas of the plant, particularly the raw materials receiving area. The sources of potential contaminated stormwater run-off may be from one or more of the following sources:

1. Loading/Unloading Areas

- Unloading areas should, ideally, be under cover to separate precipitation from product drainage from the trucks. Contaminated drainage should be directed to the sanitary sewer.

- Practise dry pick-up for all product spills.

- Hard surface the receiving area. Place curbs to divert clean runoff away from the unloading area.

2. Solid Waste Storage

- Storage areas should be roofed.

- Dumpsters should be secure, covered and leak-tight.

- Drainage from storage areas should be diverted to the sanitary sewer.

- Regularly check and clean out catch basins.

3. Truck Traffic

- Install oil intercepters at all catch basins.

- Wash trucks in a designated area. Dry clean first. Drainage to screen and settling tank as minimum pre-treatment.

4. Chemical Storage

- Keep chemicals in a secure storage room and mix area.

- Train employees responsible for handling chemicals.

- Develop and practise spill prevention and emergency clean-up procedures.

- Use drip-pans at loading docks.

6.1.8 Hazardous Substances

There are some hazardous substances used in the fruit and vegetable industry. They may include:

a) product wash agents, fungicides and floatation chemicals used in washing and other process waters;
b) biocides and descaling chemicals used in non-contact cooling waters (cooling towers);
c) solvents and oils used in processing equipment maintenance; and
d) freon, ammonia and glycols used in refrigeration cooling systems.

6.1.9 Ammonia, CFCs and Ethylene Glycol used as Refrigerants

Reduction Opportunities

(a) Keep cooling systems maintained properly to avoid emissions.
(b) Minimize releases when performing maintenance on ammonia systems, as well as freon systems.
(c) Recycle CFCs properly.
(d) Recycle the ethylene glycol used in refrigeration systems.

(e) Substitute CFCs with ammonia for large refrigeration systems or R22 (HCFCs) for smaller systems.

6.1.10 Biocides and Corrosion Inhibitors Used for Cooling Water Treatment, Cooling Towers

Reduction Opportunities

Use non-chlorinated substitutes for cleaning, lubricants and de-sticking agents.

6.1.11 Hazardous Wastes

Hazardous wastes include:

(a) sludges removed from catch basins and sumps associated with process water systems;
(b) waste solvent from baths, waste oil, antifreeze, batteries and shop rags in the maintenance shop;
(c) waste antifreeze and freon from cooling systems;
(d) waste inks, solvents and shop rags from presses in printing operations;
(e) groundskeeping: paint wastes including sand blasting and sanding wastes, waste paint, contaminated tape and paper, and pesticide waste containers, unused or leftover pesticides, rinsates and pesticide spills used in groundskeeping; and
(f) printer cartridges.

The following discussion focuses on reduction and recycling opportunities for the above waste streams.

Process Water Sludges

Chemicals used in floatation and process line waters typically adhere to soil particles and organic matter that accumulate in the bottoms of sumps, treatment tanks and filters. During processing, the concentration of substances, such as fungicides and anti-scald chemicals, may build up to levels that cause the sludges to designate as a Special Waste.

Reduction Opportunities

(a) Use screening and hydro sieves to remove large particulates, twigs and leaves. This will reduce the amount of sludge generated.
(b) Investigate using less toxic alternatives to reduce the likelihood of the sludges designating as special waste.

(c) Investigate adjusting chemical concentrations in the process waters because they may cause spent solutions and sludges to designate. If lower chemical concentrations can be used and still deliver the desired effect, then concentrations in spent solutions and sludges might be lessened and costs reduced.

Solvents used in Parts Baths and General Process Equipment Cleaning

Reduction Opportunities

(a) Replace parts-bath solvents with non-hazardous substitutes.
(b) Use filtration to extend the life of the solvents. Spent filter cartridges may be hazardous wastes. If the solvent is used only for removing greases and oils from parts and a non-hazardous solvent is being used, the filters should not designate as hazardous.
(c) Substitute hazardous cleaning agents with less hazardous alternatives.
(d) Substitute aqueous-based solvents for petroleum solvents.
(e) Substitute non-halogenated solvents for halogenated solvents.
(f) Use steam cleaning instead of solvent-based cleaning.

Recycling Opportunities

(a) Segregate the solvents from other wastes so they can be recycled.
(b) Use a vendor service that provides recyclable solvent substitutes.
(c) Use on-site or off-site distillation for recovering solvents.

Oils, Antifreeze, Batteries and Shop Rags used in Maintenance

Reduction Opportunities

(a) Use cloth rags which, when contaminated with oils, greases and solvents are exempt from the Special Waste Legislation if they are sent to a legitimate laundry for cleaning. Paper towels need to be managed and disposed of according to the Special Waste Regulations if they contain any hazardous substances.
(b) Used motor oil, generated at your own facility, is exempt from the Special Waste Regulations if it is segregated from other waste streams and recycled.
(c) All lead acid batteries are recyclable through your battery supplier or an authorized recycler. Lead acid batteries are exempt from Special Waste Legislation if they are recycled.
(d) Use on-site or off-site recycling options for spent antifreeze.

Inks, Solvents and Shop Rags used in Printing Operations

Reduction Opportunities

(a) Use non-hazardous substitutes for inks and solvents, such as water-based inks for paper and cardboard labelling and glycol ethers as cleaning solvents.
(b) Use cloth shop rags in place of paper towels. Dirty cloth rags are exempt from the Special Waste Legislation if laundered at a legitimate commercial laundry.

Recycling Opportunities

(a) Use on-site or off-site distillation for solvents.

Facility Lighting

Reduction Opportunity

(a) Replace all PCB-containing capacitors and ballasts. Capacitors still need to be handled as Special Waste because of the dielectric oils used in them.

Painting used for Grounds Maintenance

Reduction Opportunities

(a) Use non-hazardous water-based paints.
(b) Use leftover paint for areas where the colour is not critical.
(c) Find other users who can utilize the leftover paint.
(d) Purchase only the amount needed to do the job.
(e) Completely empty all paint cans containing paints with hazardous substances before discarding.

Recycling Opportunity

(a) Use off-site recycling facility, where available.

Pesticides Used for Grounds Maintenance

Reduction Opportunities

(a) Purchase and use only the amount needed for the job.
(b) Provide adequate storage to avoid damaging the products.
(c) Use the oldest material first from inventory.
(d) Find a legitimate user for the excess product for its intended purpose.
(e) Minimize changeovers from one spray solution to another.

(f) Dedicate equipment to compatible spray activities. This will reduce equipment cleaning.
(g) Use rinsates from tanks and containers as make-up for the next batch. Follow the labelling requirements.
(h) When liquid containers are triple rinsed and fibre containers are completely emptied, they are considered empty and a solid waste. Empty the fibre containers by thoroughly shaking and rinsing them.
(i) Manage banned or damaged pesticides appropriately by disposing of them at a permitted Treatment or Storage Facility, or through a provincially-sponsored collection event for waste pesticides.

Laser Printer Cartridges

Laser printer cartridges may designate as a special waste when spent.

Reduction Opportunity

Recharge spent printer cartridges so they can be reused instead of throwing them out.

6.1.12 Solid Waste

General Reduction Opportunities

(a) Eliminate disposable products wherever possible.
(b) Use ceramic coffee mugs to eliminate disposable cups.
(c) Return or reuse wooden pallets.
(d) Donate used or discarded goods and equipment to charitable organizations.
(e) Ensure that containers are completely emptied and sent off for recycling or proper disposal. Empty drums and containers in facility yards have caused many public complaints.

Recycling Opportunities

(a) Recycling markets vary in each community. Find out what recycling services are available before starting your program.
(b) Paper, cardboard, aluminum cans, glass, metals and plastics can all be recycled.
(c) Co-ordinate group recycling events when possible.

Process Solids

Reduction Opportunities

(a) Use dry cleaning methods such as air washing or brooms on floors, bins and trucks.

(b) When trucks arrive from the fields with full loads, use air-blast separation to separate product from leaves, sticks and other non-useable materials.
(c) Find users for organic solid waste such as cattle feeders, composting or field applications.

Sludge from Wastewater Treatment

Reduction Opportunities

(a) Use field cleaning to reduce the amount of cleaning required at the plant and to reduce the amount of sludge generated.
(b) Use screens, hydro sieves, filtration and other efficient systems to remove leaves, twigs and other organic matter from process waters.

Office Paper

Reduction Opportunities

(a) Reduce the use of paper by making double-sided copies.
(b) Reuse paper with a free side (single-sided) for draft copies.
(c) Circulate information rather than making several copies.
(d) Use electronic mail messages.
(e) Reuse envelopes, boxes and file folders.
(f) Centralize files.
(g) Store documents on a floppy disk rather than making paper copies.

Recycling Opportunities

(a) White office paper is readily recyclable in most communities. It must be kept separate from other paper waste.
(b) Coloured paper is not as easily recycled; therefore, its use should be limited.
(c) Provide individual containers for collection of newsprint, white, coloured and computer paper at convenient locations.

Cardboard

Reduction Opportunity
Request that deliverables be shipped in returnable containers and reuse boxes for shipping goods.

Recycling Opportunity

Most corrugated cardboard can be recycled. Contact your local recycler for details. There can be substantial savings in garbage fees when the cardboard is removed from the waste stream.

6.2 WASTEWATER TREATMENT - OVERVIEW

Primary pollutants in wastewater from fruit and vegetable processing facilities are biochemical oxygen demand (BOD) and solids. Less important pollutants from this industry include high/low pH from cleaning solutions and COD.

The BOD may be associated with the organic solid particles or in a dissolved form (fruit juices). Solids may be large pieces or particles which settle easily, or smaller suspended particles called suspended solids (SS).

There are a number of treatment methods available to reduce BOD and solids loadings in effluent. Screening is the most popular method used in the industry for solids reduction. Other methods which will remove solids from an effluent stream include settling or sedimentation, filtration, dissolved air floatation, and hydrocyclones.

BOD may be associated with the solids or in a dissolved form. Methods used for reducing solids will, therefore, also usually reduce BOD. BOD which is in a dissolved form will not be reduced utilizing solids removal equipment. In order to reduce BOD which is dissolved, biological treatment methods are required.

Biological treatment methods include lagoons, trickling filters, activated sludge systems, and rotating biological contactors. Microorganisms are used to consume organic matter and reduce the BOD of the waste. The processes may be aerobic or anaerobic, and may require nitrogen or phosphorus addition depending on the waste characteristics. The decaying microorganisms produce a wastewater sludge that must be disposed of or used. All biological processes are susceptible to external temperature fluctuations.

A flow equalization basin may be needed upstream of biological treatment to dampen the effects of changing waste characteristics. Treatment methods are discussed briefly in the following section. Following the discussion, Table 6.2 presents the relative costs of various treatment technologies. Note that these are order of magnitude costs only. Costs per m^3 of wastewater treated may be an insufficient measure of treatment economics. It is often more important to assess cost per unit of pollution parameter removed from the wastewater stream. For example, if BOD removal is important, it is instructive to evaluate cost per kg of BOD removed from the wastewater stream.

6.2.1 Screening

Screening is the most common method of reducing solids levels in fruit and vegetable processing effluent prior to discharge to a receiving environment or sewer. Screens are used at several fruit and vegetable processing facilities in the lower Fraser Valley to remove and/or recover materials such as pits, seeds, trimmings and rejects. The most common types of screens used are tangential screens and rotary drum screens. Other types include filter belt screens, vibrating screens, and wheel filters with scrapers and water spray.

Screens are popular because they are simple to operate and relatively inexpensive to install and operate. They may be used as a single unit, or in combination (pre-screen/polish screen) to attain the desired efficiency of solids removal.

Screens may be coarse (mesh size above 0.6 mm), fine (0.15 to 0.6 mm mesh size) or very fine (0.01 to 0.15 mm mesh size).

Removal efficiencies depend on the nature of the solids, mesh size, the solids and hydraulic loading of the screen and the screen design. Typically, a well-designed installation will remove 20 - 30% of suspended solids and up to 90% of settleable solids.

The location to install the screen is very important to remove solids from the wastewater as quickly as possible. This will reduce the time that waste solids are in contact with wastewater and, therefore, reduce soluble BOD content. Pumping should be avoided as much as possible as this increases the rate of solubilization of BOD and reduces the particle size of suspended solids.

6.2.2 Gravity Clarifiers

With the exception of potato processing operations, gravity clarifiers are not commonly used in the fruit and vegetable industry. In most cases, settleable solids are more economically removed by screening. For the case of berry processors, washwater is usually discharged through a settling tank.

Gravity clarifiers include rectangular settling tanks and circular tank clarifiers. An unusually long ditch at one lower Fraser Valley processing facility acts as a sedimentation basin for wastewater effluent. Solids removal may be automated by installing slow moving collectors with flights or paddles to scrape sludge from the bottom of the tank and/or skim floating scum from the surface. Separation can be enhanced by adding coagulants and/or flocculants.

Separation efficiencies for fruit and vegetable effluent depend on the commodity, but 40% reduction in suspended solids and 15 - 30% reduction in BOD_5 is typical. Sedimentation can be used for concentrated waste streams such as flume water but requires special design considerations due to the heavy soil material and grit. This material can be highly abrasive to pumps and scrapers, and can thicken to high solids concentrations making pumping difficult.

Sedimentation has been effectively used in potato processing to remove up to 50 to 90% of suspended solids and 25 - 50% of BOD at hydraulic loadings of 30 $m^3/m^2/day$ (EPS, 1979). Settled sludge is suitable as animal feed.

Sedimentation basins are relatively economical to install and operate but require large land areas due to long retention times needed to separate smaller particles.

They require relatively low maintenance and can be used in a batch or continuous mode.

6.2.3 Filtration

Filtration provides an alternative to the use of very fine screens for the removal of particles less than 0.1 mm in diameter. Filters are most commonly used in fruit and vegetable processing to dewater sludges from gravity clarifiers. Disposal costs are reduced and the dewatered sludge may be used as animal feed. Vacuum drum filters have been used in potato processing at loadings of 1 kg solids/m^2 of filter area. Filters can also be used to remove skin and pulp from caustic peeling solutions. The caustic can be reused after treatment, which reduces operating costs.

Filters may be gravity fed, vacuum type, or pressurized. Filtration of potato slicing water has been successful using sand filters, dual media gravity and pressure filters (EPS, 1979). Freshwater make-up is required if the treated water is to be recycled in the process. This is to control the accumulation of inorganic salts such as sodium, phosphorus and chloride.

Most filters operate automatically with self-regulated backwashing. The frequency of backwashing will depend on the solid content of the waste stream. The backwash water must still be treated by sedimentation or screening. Sand and multi-media filters have been used as a polishing step following biological treatment processes. Filtration of biologically-treated water results in a high quality effluent which can be chlorinated and rescued in the facility.

6.2.4 Floatation

Floatation, and particularly dissolved air floatation (DAF), has been thoroughly studied for the treatment of various fruit and vegetable processing effluent (EPS, 1979). In the floatation process, fine air bubbles are used to carry suspended solids to the surface of a tank where a mechanical skimmer removes the resultant air-and-solids foam. Although commercial units are available, there are few installations in the fruit and vegetable industry, and only one in the lower Fraser Valley.

The dissolved air floatation unit in the lower Fraser Valley is used for the removal of starch and other particulate matter from potato processing wastes. The process provides improved solids removal over sedimentation but is considerably more expensive to operate. This floatation unit offers the owner the advantage of improved solids removal, shorter retention time and smaller area requirements.

Floatation units will also remove oil and grease from wastewater; however, this material can normally be separated in gravity clarifiers or grease traps more economically.

These units require more maintenance than sedimentation basins to prevent mechanical failure which leads to a loss of treatment capability. Turbulent flows and lack of influent wastewater conditioning for pH can reduce treatment efficiencies substantially. Dissolved flocculant and carryover into the effluent stream may impact receiving water quality.

6.2.5 Hydrocyclones and Centrifuges

Hydrocyclones and centrifuges each employ centrifugal forces to separate solids from liquids; however, a hydrocyclone has no moving parts. In a hydrocyclone, the centrifugal motion is effected by the liquid entering the cone tangentially. Centrifuges and hydrocyclones are capable of separating solids and liquids with only small density differences due to the centrifugal action.

Centrifuges are not widely used in the fruit and vegetable processing industry, except for potato and cornstarch wastes and sludge dewatering. Hydrocyclones are employed at one plant in the lower Fraser Valley for starch removal from potato processing wastewater.

Solids removal efficiencies in centrifuges are far greater than efficiencies in sedimentation basins or floatation devices. Centrifuges can, therefore, be located downstream of primary treatment units to further reduce waste loadings.

Disadvantages of centrifuges are high maintenance requirements and high capital cost. Hydrocyclones, because there are no moving parts, are easily maintained.

6.2.6 Chemical Coagulation and Precipitation

Chemical coagulation and precipitation have limited application for fruit and vegetable wastes due to the high dosages required for effective treatment and the large volume of sludge produced.

Most conventional metal coagulants, including lime, alum and ferric chloride and various organic polyelectrolytes, have been evaluated in conjunction with sedimentation, floatation and centrifugation. Removal efficiencies depend on the chemical used, dosage rate and waste characteristics. Suspended solids removal may increase to 60 - 80% in sedimentation processes with the addition of chemicals (EPS, 1979). BOD removal is usually unchanged as chemical addition has no effect on soluble BOD.

It is difficult to operate chemical coagulation systems for fruit and vegetable effluent because of the changing nature of the waste as different commodities are processed. In addition, the use of coagulants may limit the use of the recovered solids as animal feed by-product. Dissolved coagulant and carryover into the effluent stream may impact receiving water quality.

Chemical coagulants may be more suited to the treatment of concentrated wastes which are not amenable to biological treatment, such as pickling brines and caustic peeling solutions.

6.2.7 Flow Equalization

A flow equalizing tank or basin is used to dampen fluctuations in hydraulic loading and waste compositions upstream of a treatment facility. The equalizing tank has the capacity to store wastewater for recycling or reuse or to feed the flow uniformly to the treatment facility.

Flow equalization is used to overcome operational problems caused by flow rate variations, to improve the performance of the downstream processes, and to reduce the size and cost of the downstream treatment facilities. Flow equalization is generally applied in processing facilities where large fluctuations in flow and/or waste characteristics are observed.

Biological treatment is enhanced downstream of flow equalization because shock loadings of inhibiting substances or high/low pH are minimized. Processes which use chemicals are more easily controlled downstream of flow equalization.

6.2.8 Aerobic Lagoons

Aerobic lagoons are shallow ponds, less than 1 m deep, where dissolved oxygen is maintained throughout the entire depth mainly by the action of photosynthesis. Aerobic lagoons permit microorganisms and algae to exist in a mutually beneficial relationship. The ponds can be inexpensive, (depending on land costs and availability) require large area and are restricted to locations where freezing conditions or high sunlight conditions are limited. The shallow depth of aerobic lagoons leads to problems with nuisance aquatic vegetation and creates a breeding area for mosquitos.

There is one aerated lagoon system being utilized for treatment of fruit and vegetable processing wastes in the lower Fraser Valley.

6.2.9 Aerated Lagoons

Lagoons which are oxygenated through the use of mechanical or diffused aeration units are termed aerated lagoons. These lagoons, up to 5 m deep, overcome the problems associated with algae growth due to the turbulence created by the aeration equipment. Air supply equipment may be surface mounted, floating or located at the lagoon bottom. The lagoons may be designed to be completely aerated (Aerobic Lagoon) or partially aerated (Facultative Lagoon). Retention times decrease in the former; however, power levels to operate the diffusers increase.

The effluent from an aerated lagoon will be high in BOD due to suspension of solids in the lagoon from the diffusers. A clarifier, or settling pond, is required downstream of an aerated lagoon.

6.2.10 Anaerobic Lagoons

Anaerobic lagoons are typically 2.5 - 3 m deep and offer the advantage of requiring less area, virtual elimination of sludge mats and suitability for high strength wastes. A lagoon can be kept anaerobic by applying a BOD load that exceeds oxygen production from photosynthesis. Photosynthesis is reduced by decreasing surface area and increasing depth.

Anaerobic lagoons have been used to treat fruit and vegetable wastes. The following table shows typical operating data for several fruit and vegetable effluent.

Table 6.1: Operating Data for Anaerobic Ponds Treating Industrial Wastewaters

	BOD_5 Concentration (mg/L)				
Type of Waste	***Influent***	***Effluent***	***BOD_5 Removal (%)***	***BOD_5 Loading (lb./1,000 ft^3-day)***	***Temperature (EC)***
Fruit	3,380	445	86.8	630[a]	
Tomato	728	163	77.6	628[a]	
Citrus	939	241	74.4	662[a]	
Tomato	982	599	39.8	33.9	14-24
Peas	1,444	-	37	23.2	
Corn	2,164	-	47.5	15.9	-
Corn Products	<4,000	- -	58 92	- -	21 38

Source: Benefield, 1980

[a] lb. BOD_5/acre-day

Anaerobic lagoons are susceptible to changes in temperature and produce odours due to the anaerobic action. Floating covers may be used to retain heat in the lagoon in northern climates and add the advantage of providing odour control.

Sludge removal requirements are reduced in anaerobic lagoons as settled sludge is degraded (stabilized) through anaerobic processes.

6.2.11 Trickling Filters

Trickling filters, rotating biological contactors and other biological filters are all examples of attached-growth biological treatment processes. Trickling filters may be high-rate (10 - 40 m^3/m^2/day, 0.4 - 1.85 kg BOD/m^3 filter volume/day) or standard rate (1 - 4 m^3/m^2/day, 0.1 - 0.4 kg BOD/m^3 filter volume/day). Stone or synthetic media may be used.

Trickling filters do not generally provide as efficient a level of treatment, or as much design flexibility, as the activated sludge process. Sloughing may occur when the biological film on the media loses its ability to stay attached. Trickling filter processes, however, offer ease of operation and generally lower costs than activated sludge systems to install and operate. To the author's knowledge, there are no trickling filter installations for wastewater treatment in fruit and vegetable processing plants in the lower Fraser Valley.

6.2.12 Activated Sludge

The activated sludge process usually includes an aerated grit chamber, primary clarifier, aeration tank and secondary clarifier. Sludge is recycled from the secondary clarifier back to the aeration tank, and improves BOD removal. The term Aactivated sludge@ is used since the returned sludge has microorganisms that actively decompose the waste being treated. Soluble BOD levels can be reduced to less than 10 - 15 mg/L; however, solids carryover in the secondary clarifier can increase these levels.

Activated sludge systems are used when high effluent quality is desired, land is limited and wastewater flows are above 100,000 gal./day

Because the process has a short detention time, it takes skill to operate and is sensitive to toxic and hydraulic shocks. It also requires disposal of excess sludge.

6.2.13 Rotating Biological Contactors

The Rotating Biological Contactor (RBC) is an attached-growth type of biological treatment. This system consists of a large number of closely spaced large-diameter disks (3 m in diameter) mounted on a horizontal shaft. The disks are partially (30 - 40%) immersed and rotate slowly (1 - 2 rpm) as wastewater passes through a horizontal open tank. Microorganisms attach themselves to the discs and grow by assimilating nutrients from the wastewater. Aeration is provided by the rotating action, which exposes the disk to the air after contact with the water. A hydraulic loading of 0.14 $m^3/day/m^2$ of surface will normally achieve approximately 95%

BOD_5 and 92% TSS reductions. The biofilm undergoes sloughing, as in trickling filters, and these solids must be settled and removed in a downstream clarifier.

Rotating biological contactors are capable of handling a wide range of flows (1,000 gal./day to 100 million gal./day), require short contact times because of the large surface area and are easy to operate. Initial costs of this equipment may be high. The units are preferred where land costs are high or when land is not readily available.

Table 6.2:Relative Wastewater Treatment Costs

Technology	**Ref.**	**Relative Cost ($/m^3 treated)**
Screening	6.2.1	$0.20
Gravity clarifier	6.2.2	$0.30
Trade waste interceptor	6.2.2	$0.05
Filtration	6.2.3	$0.40
Floatation	6.2.4	$0.70
Hydrocyclones	6.2.5	$0.30
Centrifuges	6.2.5	$0.90
Coagulation	6.2.6	$0.70
Flow equalization	6.2.7	$0.20
Aerobic lagoons	6.2.8	$0.20*
Aerated lagoons	6.2.9	$0.40*
Anaerobic lagoons	6.2.10	$0.20*
Trickling filters	6.2.11	$0.50
Activated sludge	6.2.12	$0.90
Rotating biological contractor	6.2.13	$0.50

Order of magnitude costs for complete installations, including estimated cost of capital borrowing, depreciation on equipment, maintenance, utilities and material.

** land costs not included.*

Treated volume assumed to be 70,000 m3 per year.

APPENDIX A

Processor Data for Lower Fraser Valley

Plant No. 1

Operation: Frozen vegetable and berry processor

Average production:

CROP	DATE RECEIVED	HOURLY PRODUCTION (lb.)	ANNUAL PRODUCTION (lb.)
Strawberries	May - July	2,500	1,300,000
Peas	June - August	7,800	4,500,000
Beans	July - August	4,400	1,600,000
Corn	August - October	6,250	3,500,000
Broccoli	September - October	2,500	500,000
Brussels Sprouts	November	2,500	750,000
Other			1,400,000

Water consumption:

OPERATION	FLOW (USgpm)	FLOW (USG per annum)
Washing feedstock	200	11,500,000
Blanching	40	700,000
Cooling post-blanching	50	3,400,000
Clean-up	100	6,700,000
Other processes and domestic	10	5,000,000

Connection to city sewer: Yes

Pre-treatment works: Internally-fed rotating screen

This plant is one of the major processors in the Fraser Valley. Their production consists of receiving fresh vegetables, washing and preparation, blanching, cooling, IQF freezing by fluidized bed air-blast freezing, packaging and holding finished products in freezer storage.

Water supply is from a combination of on-site wells and local utility. There are connections to both sanitary and stormwater sewers. Pre-treatment is by screening to remove solids.

Organic solid waste is collected off processing lines and stored temporarily in dumpsters. Disposal options utilized include agricultural land spreading, composting and cattle feeding.

Plant No. 2

Operation: Frozen vegetable and berry processor

Average production:

CROP	DATE RECEIVED	HOURLY PRODUCTION (lb.)	ANNUAL PRODUCTION (lb.)
Strawberries	May - July	10,000	3,000,000
Raspberries	June - August	5,000	1,500,000
Peas	June - August	15,000	4,000,000
Beans	July - August	13,000	3,500,000
Cauliflower	August - October	10,000	2,000,000
Broccoli	September - October	11,000	2,200,000
Brussel Sprouts	November	14,000	3,200,000

Water consumption:

OPERATION	FLOW (US gpm)	FLOW (USG per annum)
Washing feedstock	250	18,000,000
Blanching	75	1,500,000
Cooling post-blanching	100	11,000,000
Clean-up	100	10,000,000
Other processes and compressor cooling and defrost	50	5,000,000

Connection to city sewer: Yes

Pre-treatment works: Externally-fed rotating screen

This plant is one of the major processors in the Fraser Valley. Their production consists of receiving fresh vegetables, washing and preparation, blanching, cooling, IQF freezing by fluidized bed air-blast freezing, packaging and holding finished products in freezer storage.

Water supply is from a combination of on-site wells and local utility. There are connections to both sanitary and stormwater sewers. Pre-treatment is by screening to remove solids.

Organic solid waste is collected off processing lines and stored temporarily in dumpsters. Disposal options utilized include agricultural land spreading, composting and cattle feeding.

Plant No. 3

Operation: Frozen vegetable repacker

Average production:

CROP	DATE RECEIVED	HOURLY PRODUCTION (lb.)	ANNUAL PRODUCTION (lb.)
Mushrooms	year-round	N/A	N/A

Water consumption:

OPERATION	FLOW (USgpm)	FLOW (USG per annum)
Washing feedstock	N/A	N/A
Blanching	N/A	N/A
Cooling post-blanching	N/A	N/A
Clean-up	20	500,000
Other processes and compressor cooling and defrost		Total flow less than 300 m^3 per month

Connection to city sewer: Yes

Pre-treatment works: Screening

This plant packs only frozen mushrooms on a limited run basis about twice per week. The balance of the operation is repacking frozen bulk vegetables. Therefore, there is very little process water consumed in the plant. Clean-up is the major use of water. In addition, the operation has taken steps to recycle compressor cooling and vacuum packaging machine cooling water flows. The expected flow from the plant is less than 300 m^3 per month.

N/A - Data not available.

Plant No. 4

Operation: Frozen berry processor

Average production:

CROP	DATE RECEIVED	HOURLY PRODUCTION (lb.)	ANNUAL PRODUCTION (lb.)
Raspberries	June - August	35,000	12 - 15,000,000

Water consumption:

OPERATION	FLOW (USgpm)	FLOW (USG per annum)
Washing feedstock	40	2,000,000
Clean-up	10	200,000
Other processes		

Connection to city sewer: Yes

Pre-treatment works: Dual settling tanks in series

This plant is a major berry processor in the Fraser Valley. Their production consists of receiving fresh berries, air separation of trash, washing, sorting by hand, IQF freezing, packaging and holding finished products in freezer storage.

Water supply is from the local utility. There are connections to both sanitary and stormwater sewers. Pre-treatment is by gravity settling.

Organic solid waste is collected off processing lines and stored temporarily in dumpsters. Disposal options utilized include agricultural land spreading, composting and cattle feeding.

Plant No. 5

Operation: Frozen berry processor

Average production:

CROP	DATE RECEIVED	HOURLY PRODUCTION (lb.)	ANNUAL PRODUCTION (lb.)
Blueberries	June - August	2,900	13,000,000
Raspberries	June - August	1,000	5,000,000

Water consumption:

OPERATION	FLOW (USgpm)	FLOW (USG per annum)
Washing feedstock	1	60,000
Clean-up	12	200,000
Other processes		

Connection to city sewer: Yes

Pre-treatment works: None

This plant is a major berry processor in the Fraser Valley. Their production consists of receiving fresh berries, air separation of trash, washing, sorting by hand, IQF freezing, packaging and holding finished products in freezer storage.

Water supply is from the local utility. There are connections to both sanitary and stormwater sewers.

Organic solid waste is collected off processing lines and stored temporarily in dumpsters. Disposal options utilized include agricultural land spreading, composting and cattle feeding.

Plant No. 6

Operation: Fresh vegetable packer

Average production:

CROP	DATE RECEIVED	HOURLY PRODUCTION (lb.)	ANNUAL PRODUCTION (lb.)
Potatoes	August - October	26,000	38,000,000
Carrots	August - November	10,000	10,000,000
Rutabagas	August - October	12,000	1,600,000
Beets	July - September	10,000	1,000,000
Parsnips	August - October	8,000	400,000

Water consumption:

OPERATION	FLOW (USgpm)	FLOW (USG per annum)
Washing feedstock	N/A	31,000,000
Hydro-cooling carrots, beets, parsnips	N/A	1,000,000
Clean-up	N/A	150,000
Other processes and domestic	N/A	1,000,000

Connection to city sewer: No

Pre-treatment works: Settling lagoon

Recycling: 20% of washwater is returned for primary wash on potato line.

This plant is the major fresh-pack vegetable processor in the Fraser Valley. Their production consists of receiving fresh vegetables, washing, sorting and grading, packaging and holding finished products.

Water supply is from the local utility. There are no connections to storm sewer. The sanitary sewer connection is for domestic only. Effluent discharge is to the Fraser River under permit.

Organic solid waste is collected off processing lines and stored temporarily in dumpsters. Disposal options utilized include agricultural land spreading, composting and cattle feeding.

N/A - Data not available.

Plant No. 7

Operation: Frozen vegetable and berry processor

Average production:

CROP	DATE RECEIVED	HOURLY PRODUCTION (lb.)	ANNUAL PRODUCTION (lb.)
Strawberries	May - July	N/A	500,000
Raspberries	June - August	N/A	1,500,000
Cauliflower	August - September	N/A	600,000
Broccoli	September - October	N/A	600,000
Brussel Sprouts	November	N/A	500,000

Water consumption: Estimated 50 USgpm

Connection to city sewer: No

Pre-treatment works: Screening

This plant is a small processor in the Fraser Valley. Their production consists of receiving fresh vegetables, washing and preparation, blanching, cooling, IQF freezing by fluidized bed air-blast freezing, packaging and holding finished products in freezer storage.

Water supply is from on-site wells. There is a connection to sanitary sewer for domestic waste only. Process effluent disposal is by seepage pond.

Organic solid waste is collected off processing lines and stored temporarily in dumpsters. Disposal options utilized include agricultural land spreading, composting and cattle feeding.

N/A - Data not available.

Plant No. 8

Operation: Mushroom processor

Average production:

CROP	DATE RECEIVED	HOURLY PRODUCTION (lb.)	ANNUAL PRODUCTION (lb.)
Mushrooms	year-round	N/A	N/A

Water consumption:

OPERATION	FLOW (USgpm)	FLOW (USG per annum)
Washing feedstock	N/A	N/A
Blanching	N/A	N/A
Cooling post-blanching	N/A	N/A
Slicer	N/A	N/A
Belt cleaning	N/A	N/A
Can filler	N/A	N/A
Retort cooling	N/A	N/A
Clean-up	N/A	N/A
Other processes and domestic	N/A	N/A

Connection to city sewer: Yes

Pre-treatment works: Internally-fed rotating screen

This plant is one of the major vegetable processors in the Fraser Valley. Their production consists entirely of a single crop. The process consists of receiving fresh mushrooms, washing and preparation, steam blanching, cooling, slicing, can filling, can seaming, thermal processing in retorts, can labelling, casing, palletizing and holding finished products in storage.

There is little information available from this processor; however, little recycling is done although it is recognized that many of the operations consume large quantities of recoverable water. Pre-treatment is by screening to remove solids.

Organic solid waste is collected off processing lines and stored temporarily in dumpsters. Disposal options utilized include agricultural land spreading, composting and cattle feeding.

N/A - Data not available.

Plant No. 9

Operation: Frozen berry processor

Average production:

CROP	DATE RECEIVED	HOURLY PRODUCTION (lb.)	ANNUAL PRODUCTION (lb.)
Raspberries	June - August	N/A	2,300,000

Water consumption:

OPERATION	FLOW (USgpm)	FLOW (USG per annum)
Washing feedstock	N/A	N/A
Clean-up	N/A	N/A
Other processes	N/A	N/A

Connection to city sewer: Yes

This plant is a small berry processor in the Fraser Valley. Their production consists of receiving fresh berries, air separation of trash, washing, sorting by hand, IQF freezing, packaging and holding finished products in freezer storage.

Water supply is from the local utility. There are connections to both sanitary and stormwater sewers. The plant leases space from a freezer storage plant and, therefore, the details of the utility connections, charges and volumes were not available.

Organic solid waste is collected off processing lines and stored temporarily in dumpsters. Disposal options utilized include agricultural land spreading, composting and cattle feeding.

N/A - Data not available.

APPENDIX B

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APPENDIX C

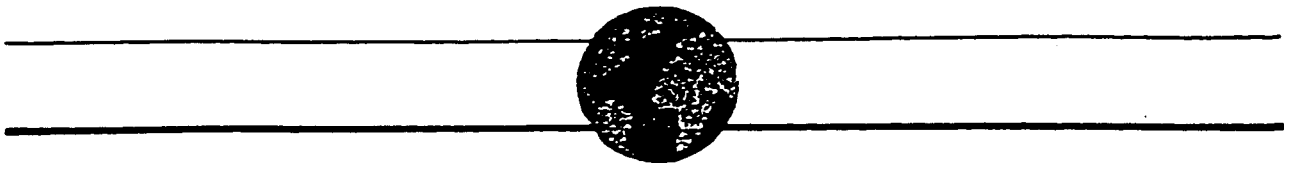
Environmental Policy Statements

ENVIRONMENTAL POLICY STATEMENTS

This appendix contains a framework for developing corporate environmental policy and a policy statement.

The first example is from CERES, The Coalition for Environmentally Responsible Economics, which is an association of over 350 socially conscientious investors. The attached statement of principles follows the Exxon Valdes oil spill in the Gulf of Alaska in 1989.

The second framework presented is from The Environmental Law Institute which is based on a survey of several companies.



VALDEZ PRINCIPLES

1990

By adopting these principles, we publicly affîrm our beiief thar corporations and their shareholders have a direct responsibility for the environment. We believe that corporations must conduct their business as responsible stewards of the environment and seek profits only in a manner that leaves the Earth healthy and safe. We believe that corporations must not compromise the ability of future generations to sustain their needs. We recognire this to be a long-term commitment to update our practices continually in light of advances in technology and new understandings in health and environmental science. We intend to make consistent, measurable progress in implementing these principles and to apply them wherever we operate throughout the world.

1. Protectlon of the Biosphere

We will minimize and strive to eliminate the release of any pollutant that may cause environmental damage to the air, water, or earth or its inhabitants. We will safeguard habitats in rivers. lakes, wetlands. coastal zones and oceans and will minimize contributing to the greenhouse effect, depletion of the ozone layer. acid rain or smog.

2. Sustainable Use of Natural Resources

We will make sustainable use of renewable natural rewources such as water, soils and forests. We will conserve non-renewable natural resourccs through efficient use and careful planning. We will protect wildlife habitats. open spaces and wildemess. whiie preserving biodiversity.

3. Reduction and Dlsposal of Waste

We will minimize the creation of waste, especially hazardous waste, and wherever possible recycle materials. We will dispose of all wastes through safe and responsible methods.

4. Wise Use of Energy

We will make every effort to use environmentally safe and sustainable energy sources to meet our needs. We will invcst in improved energy efficiency and conservation in our operations. We will maximize the energy efficiency of products we produce or sell.

5. Risk Reduction

We will minimize the environmental. health and safety risks to our employees and the communities in which we operate by employing safe technologies and operating procedures and by being constancly prepared for emergencies.

6. Marketlng of Safe Products and Servlces

We will sell products or servicesthat minimize adverse environmental impacts and that are safe as consumers commonly use them. We will inform consumers of the environmental impacts of our products or services.

7. DamageCompensation

We will take responsibility for any harm we cause to the environment by making every effort to fully restore the environment. and to compensate those pcrsons who are adversely affected.

8. Disclosure

We will disclose to our employees and to the public incidents relating to our operations that cause environmentd harm or pose health or safety hazards. We will disclose potential environmental, health or safety hazards posed by our operations, and we will not take any action against employees who report any condition that creatcs a danger to the environment or poses health and safety hazards.

9. Environmental Directors and Managers

At least one member of the Board of Directors will be a person qualified to representeenvironmental interests. We will commit management resources to implement these Principles, including the funding of an office of Vice-President for Environmental Affairs or an equivalent executive position. reporting directly to the CEO, to monitor and report upon our implementation efforts.

10. Assessment and Annual Audit

We will conduct and make public an annual self-evaluation of our progress in implementing these Principles and in complying with all applicable laws and regulations throughout our worldwidc operations. We will work toward thc timely creation of independent environmental audit procedures which we will complete annually and make available to the public.

1. General Goals: A broad standard that a company expects its environmental performance to meet or exceed. Some company policies include only goals, while others include more specific objectives, and a few - implementing mechanisms.

    1. Compliance With the Law - one of the most common objectives - includes legal categories (e.g. pollution, health) and coverage of subsidiaries and foreign operations.

    2. Environmental Protection - most common standard found; often serves as the cornerstone of a company's environmental policy.

        - Risk Management - Minimizing or eliminating the risk of harm to the environment or human health from pollution was one of the most common variations on the theme of environmental protection.

        - Environmental Stewardship - another variation on the environmental protection theme that includes protection of the environment, particularly the companies' natural resources, in a morally, ethically or socially responsible manner for present and future generations.

    3. Leadership - the concept of social or industry leadership implies exernplary or innovative behavior and is thus distinct from the concept of environmental stewardship.

    4. Public Responsiveness - this standard involves a company recognizing and satisfying public or customer concerns about its environmental performance.

II. Program Objectives: A specific environmental objective that a company believes is fundamental to achieving its broad environmental goal.

General Program Objectives

1. Source Reduction - reduction and/or elimination of the generation, discharge and/or use of a potential pollutant or waste.

2. Proper Treatment, Storage, Transportation and Disposal - implicitly acknowledges that in some industries it is impossible to eliminate or recycle pollution or waste generated or used by the industry, but provides for a commitment by the company to take proper steps to protect the public and/or the environment from the harmful or negative effects that could

occur in the treatment, storage, transportation or disposal of such pollution or waste.

3. Conservation of Natural Resources - many variations: utilizing natural resources efficiently, using natural resources in a sustainable manner, using renewable resources, and carefully managing resources.

4. Product Stewardship - involves the incorporation of environmental, and commonly health and safety, consideration in the planning, design, production and distribution of a product.

Specialized Program Objectives - Focus on a specific environment or company program

1. Groundwater Protection

2. Surface Water Protection

3. Air Emissions Reduction

4. Biological Diversity

5. Energy Efficiency

6. Preferential or Integrated Waste/Pollution Management Systems

III. Implementing Mechanisms: The practices and procedures a company uses to achieve its program objectives or general goals. These may be published in employer manuals, in separate implementation program documents or as part of the corporate policy

Common Implementing Mechanisms - Found in Many Corporate Policies

1. Development of Internal Standards - the thrust of these principles is a commitment to develop internal company standards for protection of the environment on aspects where no laws or regulations exist or where existing laws or regulations do not go far enough. They may also come into play when a company is operating in a country that does not have adequate environmental protection laws.

2. Assignment of Responsibility - falls into two categories: those that assign general responsibility to all employees and those that assign specific responsibilities to different levels of management and/or employees.

3. Recycling - commonly address intemal recycling programs of waste materials; industries that are involved in the production of potentially recyclable products or products with potentially recyclable packaging tend to have principles that support efforts to encourage public recycling through the use and production of recyclable products and packaging, coding of recyclable products and packaging, and participation in public recycling efforts, research and education.

4. Assessment of Environmental Impact - falls into two categories: those that require consideration of environmental factors in the planning and development of a company's products, processes and/or facilities and those that require consideration of environmental factors in connection with the acquisition, leasing, sale and/or divestiture of company property.

5. Communication and Training - addressed to employees and/or members of the public an generally seek to protect those persons from environmental, safety and or health hazard associated with a company's products or operations by the provision of information on training.

6. Remediation - a commitment by a company to take responsibility for and correct environmental, health or safety problems resulting from its past or future actions.

7. Communication and Cooperation to Develop Environmental Standards and Solutions - address outreach efforts by a company to the community, the govemment, trade associations and/or public interest groups to develop public policies, programs, and laws protective of the environment.

8. Environmental Compliance Programs - a commitment by a company to conduct some type of review and/or self-monitoring program that will assure compliance of a company's operations with the company's environmental policy or applicable laws or regulations; one of the most popular programs specifically referenced for assuring environmental compliance is the environmental audit.

9. Research and Development - a commitment to conduct or support intemal or external research and development programs for environmentally protective products or technology.

10. Commitment of Resources - a general commitment to provide the resources necessary implement a company's environmental policy.

11. Changing or Eliminating Products or Processes -a commitment to discontinue any or certain hazardous or harmful processes or products.

12. Contractor Compliance - a commitment to monitor performance of independent contractors worlcing for the company for compliance with a company's environmental policy or applicable laws and regulations, and to select for use by the company only those contractors whose performance meets such standards.

Specialized Implementing Mechanisms - Found in a Specific Industry or Small Number of Companies

1. Specific product or Process Changes
2. High-Level Corporate Involvement With Policy Violations
3. Encouraging and Rewarding Positive Employee Performance
4. Disciplining Employee Violations
5. Goal Setting
6. Prompt Response to Environmental Problems
7. Secondary Uses of Property
8. Environmentally Beneficial Technology and Product Applications
9. Prioritizing of Environmental Issues
10. Supporting Public Transportation
11. Supporting Environmental Organizations
12. Specific Research and Development Projects
13. Defining Criteria for "Unacceptable Risks"
14. Defining Criteria for "Environmentally Friendly" Product Packaging
15. Supporting Community Recycling Programs
16. Employing Best Control Methods
17. Annual Environmental Performance Report
(Summary by Jennifer Snyder, 1991)

APPENDIX D

Environment-related Government Funding Programs within BC

Appendix D Environment-Related Government Funding Programs Available To Companies Within British Columbia

Name of Program	Purpose	Type of Assistance	Program Administrator
Agriculture Land Development Agreement (ALDA)	To promote land development for agricultural purposes.	Provides low interest loans for projects entailing environmentally-sound drainage, irrigation, land clearing, and animal waste disposal practices.	Director, Financial Development Programs Branch Ministry of Agriculture and Fisheries Victoria (604) 356-1822
Mine Development Program	To support industrial infrastructure for the development of remote and potentially valuable ore bodies.	Grants of up to 50 per cent of the cost of environmental studies and engineering designs.	Ministry of Energy, Mines and Petroleum Resources Victoria (604) 387-5178
Energy Efficiency and Technology Program	To encourage the construction of independent power projects, which improve current environmental conditions, such as woodwaste thermal generation stations that replace waste wood burners of landfills.	At the request of the Province, B.C. Hydro will allow for a price premium of up to 15 per cent when evaluating environmentally beneficial proposals to supply privately generated electricity for the B.C. Hydro domestic system.	Ministry of Energy, Mines and Petroleum Resources Victoria (604) 356-2154
Science and Technology Development Fund—Assistance Grants for Applied Research (STDF-AGAR) Program Industry-based Research and Development Component	To promote collaboration between industry and the province's research community for industry-based research and development of products and processes, technology transfer and human resources.	Approved research projects will receive up to 50 per cent matching grants for private sector activities.	Science Council of B.C. Burnaby (604) 438-2752
Science and Technology Development Fund—Assistance Grants for Applied Research (STDF-AGAR) Program Core Funding Component	To consider applied research and technology development projects in various economic sectors, including: forestry and forest products, mining and minerals and metals, manufacturing and environment, fishing and aquaculture and food, transportation and tourism. Eligible technologies include electronics, computing and software, biotechnology, advanced materials, artificial intelligence and robotics.	Grants of up to 100 per cent of total project costs available for approved research.	Science Council of B.C. Burnaby (604) 438-2752

Appendix D (Cont'd) Environment-Related Government Funding Programs Available To Companies Within British Columbia

Name of Program	Purpose	Type of Assistance	Program Administrator
Advanced Manufacturing Technology Application Program	To assess the commercial and technical feasibility of a comprehensive upgrading of manufacturing operations through the application of advanced manufacturing technology.	Funding is available for qualified firms to engage outside expertise to conduct commercial and technical feasibility assessments.	Industry, Science and Technology Canada, British Columbia Vancouver (604) 666-0266
Canada Awards for Business Excellence	To honour outstanding achievers in Canadian business. The award categories include: invention, innovation, industrial design, labour/management cooperation, entrepreneurship, marketing, productivity, small business, environment and quality.	Winners may use the CABE logo on their products and publications. The awards are open to businesses of all sizes and in all fields of economic activity located in Canada.	Industry, Science and Technology Canada, British Columbia Vancouver (604) 666-0266
Sector Competitiveness Initiatives	To improve the international competitiveness of specific Canadian industry sectors; especially in terms of economic opportunities and benefits, and the application of technologies and innovations.	Funding is available on a joint industry/government basis. To date, sector campaigns have been improved in the areas of automotive components, manufactured wood products, environmental industries, medical devices, advanced manufacturing technology, fashion industry and national forest products.	Industry, Science and Technology Canada, British Columbia Vancouver (604) 666-0266
Strategic Technologies Program	To support research and development and technology application alliances in information technology, biotechnology and advanced industrial materials.	Financial assistance is available through industry-lead government alliances. These alliances can also involve foreign firms, universities or research institutes that wish to pool resources on pre-competitive research and development, and on pre-commercial technology application projects.	Industry, Science and Technology Canada, British Columbia Vancouver (604) 666-0266
Fraser River Action Plan	For pilot-scale technology demonstration projects, on-site field evaluations or demonstration / deci uppo ;.	Projects located in the Fraser River basin. Maximum amount per project is $35,000. Co-funding with government, dustry cation itue (NGO.	Fraser Pollution Abatement Office, Environment Canada. Lisa Walls 604-666-3487

APPENDIX E

Total Cost Accounting - EPA Facility

Pollution Prevention Guide (USEPA/600R-92/088)

CHAPTER 6
ECONOMIC ANALYSIS OF POLLUTION PREVENTION PROJECTS

Although businesses may invest in pollution prevention because it is the right thing to do or because it enhances their public image, the viability of many prevention investments rests on sound economic analyses. In essence, companies will not invest in a pollution prevention project unless that project successfully competes with alternative investments. The purpose of this chapter is to explain the basic elements of an adequate cost accounting system and how to conduct a comprehensive economic assessment of investment options.

A proposed pollution prevention option must compete with alternative investments.

TOTAL COST ASSESSMENT

In recent years industry and the EPA have begun to leam a great deal more about full evaluation of prevention-oriented investments. In the first place, we have learned that business accounting systems do not usually track environmental costs SO they can be allocated to the particular production units that created those wastes. Without this sort of information, companies tend to lump environmental costs together in a single overhead account or simply add them to other budget line items where they cannot be disaggregated easily. As a result, companies do not have the ability to identify those parts of their operations that cause the greatest environmental expenditures or the products that are most responsible for waste production. This chapter provides some guidance on how accounting systems cari be set up to capture this useful information better.

Standard accounting systems do not track environmental costs well.

It has also become apparent that economic assessments typically used for investment analysis may not be adequate for pollution prevention projects. For example, traditional analysis methods do not adequately address the fact that many pollution prevention measures will benefit a larger number of production areas than do most other kinds of capital investment Second, they do not usually account for the full range of environmental expenses companies often incur. Third. they usually do not accommodate a sufficiently long time horizon to allow full evaluation of the benefits of many pollution prevention projects. Finally, they provide no mechanisrn for dealing with the probabilistic nature of pollution prevention benefits, many of which cannot be estimated with a high degree of certainty. This chapter provides guidance on how to overcome these problems as well.

Economic analysis of pollution prevention projects is complex because they:

- ***affect muitiple areas***
- ***have long rime horizons***
- ***have probabilistic benefits***

In recognition of opportunities to accelerate pollution prevention. the U.S. EPA has funded several studies to demonstrate how economic assessments and accounting systems can be modified to improve the competitiveness of prevention-oriented investments. EPA calls this analysis Total Cost Assessment (TCA). There are four elements of Total Cost Assessmenr expanded cost inventory, extended time horizon. use of long-tern financial indicators, and direct allocation of costs to processes and products. The first three apply to feasibility assessment while the fourth applies to cost accounting. Together these four elements will help you to demonstrate the truc costs of pollution to your firm as well as the net benefits of prevention. In addition. they help you show how prevention-oriented investments compete with company-defmed standards of profitability. In sum, TCA provides substantial benefits for pre-implementation feasibility assessments (see Chapter 2 on preliminary assessments and Chapter 3 on feasibiity anaiysis) and for post-implementation project evaluation (see Chapter 4 on measuring progress.)

Elements of Total Cost Assessment:

- ***expanded cost inventory***
- ***extended time horizon***
- ***use of long-term indicators***
- ***allocation of costs by area***

The remainder of this chapter summarizes the essential characteristics of TCA. Much of the information is drawn from a report recently prepared for the U.S. EPA by Tellus Institute. (See Appendix G for the full citation.) The Tellus report addresses TCA methodology in much greater detail than can be provided here and provides examples of specific applications from the pulp and paper industry. The report also includes an extensive bibliography on applying TCA to pollution prevention projects. In a separate but related study for the New Jersey Department of Environmental Protection, Tellus analyzed TCA as it applies to smaller and more varied industrial facilities. A copy of this report cari be obtained from the N.J. Department of Environmental Protection.

TCA methodology has been the topic of several government studies.

EXPANDED COST INVENTORY

TCA includes not only the direct cost factors that are part of most project cost analyses but also indirect costs. many of which do not apply to other types of projects. Besides direct and indirect costs, TCA includes cost factors related to liability and to certain "less-tangible" benefits.

TCA analyzes

- ***direct costs***
- ***indirect costs***
- ***liability costs***
- ***less tangible benefits***

TCA is a flexible tool that can be adapted to your specific needs and circumstances. A full-blown TCA will make more sense for some businesses than for others. In either case it is important to remember that TCA can happen incrementally by gradually bringing each of its elements to the inveslment evaluation process. For example, while it may be quite easy to obtain information on direct costs, you may have more trouble estimating some of the future liabilities and less tangible costs. Perhaps your first effort should incorporate all direct costs and as many indirect costs as possible. Then you might add those costs that are more difficult to estimate as increments to the initial analysis. thereby

highlighting to management both their uncertainty and their importance.

Direct Costs

For most capital investments. the direct cost factors are the only ones considered when project costs are being estimated. For pollution prevention projects, this category may be a net cost, even though a number of the components of the calculation will represent savings. Therefore, confining the cost analysis to direct costs may lead to the incorrect conclusion that pollution prevention is not a sound business investment.

Dùect Costs
Capital Expenditures
- ***Buildings***
- ***Equipment and Installation***
- ***Utility Connections***
- ***Project Engineering***

Operation and Maintenance Expenses or Revenues
- ***Raw Materials***
- ***Labor***
- ***Waste Disposa1***
- ***Water and Energy***
- ***Value of Recovered Material***

Indirect Costs

For pollution prevention projects, unlike more familiar capital investments, indirect costs are likely to represent a significant net savings. Administrative costs, regulatory compliance costs (such as permitting recordkeeping. reporting, sampling, preparedness, closure/post-closure assurance), insurance costs, and on-site waste management and pollution control equipment operation costs can be significant. They are considered hidden in the sense that they are either allocated to overhead rather than their source (production process or product) or are altogether omitted from the project financial analysis. A necessary first step in including these costs in an economic analysis is to estimate and allocate them to their source. See the section below on Direct Cost Allocation for several ways to accomplish this.

Indirect Costs
Administrative Costs
Regulatory Compliance Costs
- ***Permitting***
- ***Recordkeeping and Reporting***
- ***Monitoring***
- ***Manifesting***

Insurance
Workman's Compensation
On-Site Waste Management
On-Site Pollution Control Equipment Operation

Liability Costs

Reduced liability associated with pollution prevention investments may also offer significant net savings to your company. Potential reductions in penalties, fines, cleanup costs, and personal injury and damage claims can make prevention investments more profitable. particularly in the long run

In many instances, estimating and allocating future liability costs is subject to a high degree of uncertainty. It may, for example. be difficult to estimate liabilities fiom actions beyond your control. such as an accidental spill by a waste hauler. It may also be difficult to estimate future penalties and fines that might arise from noncompliance with regulatory standards that do not yet exist. Similarly. personal injury and property damage claims that may result from consumer misuse. from disposal of waste later classified as hazardous, or from claims of accidental release of hazardous waste after disposal are difficult to estimate. Allocation of future liabilities to the products or production processes also presents practical difficulties in a cost assessment. Uncertainty, therefore. is a significant aspect of a cost assessment and one that top management may be unaccustomed to or unwilling to accept.

Liability Costs
Penalties
Fines
Persona1 Injury
Property Damage
Natural Resources Damage Clean-up costs
- ***Superfund***
- ***Corrective Action***

Some firms have nevertheless found alternative ways to address liability costs in project analysis. For example. in the narrative accompanying a profitability calculation, you could include a calculated estimate of liability reduction, cite a penalty or settlement that may be avoided (based on a claim against a similar company using a similar process), or qualitatively indicate without attaching dollar value the reduced liability risk associated with the pollution prevention project. Altematively, some firms have chosen to loosen the financial performance requirements of their projects to account for liability reductions. For example, the required payback period can be lengthened from three to four years. or the required intemal rate of return can be lowered from 15 to 10 percent. (See the U.S. EPA's ***Pollution Prevention Benefits Manual Phase II. as*** referenced in Appendix G, for suggestions on formulas that may be useful for incorporating future liabilities into the cost analysis.)

Less-Tangible Benefits

A pollution prevention project may also deliver substantial benefits from an improved product and company image or from improved employee health. These benefits, listed in the cost allocation section of this chapter. remain largely unexarnined in envirorunental investment decisions. Although they are often difficult to measure. they should be incorporated into the assessment whenever feasible. At the very least. they should be highlighted for managers after presenting the more easily quantifiable and allocatable 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 10 Improved Employee Relations
Improved Relationships with Regulators

Consider several examples. When a pollution prevention invesunent improves product performance to the point that the new product can be differentiated from its competition. market share may increase. Even conservative estimates of this increase can incrementally improve the payback from the pollution prevention investrnent Companies similarly recognize that the development and marketing of so-called "green products" appeals to consumers and increasingly appeals to intermediate purchasers who are interested in incorporating "green" inputs into their products. Again. estimates of potential increases in sales can be added to the analysis. At the very least. the improved profitability from adding these less-tangible benefits to the analysis should be presented to management alongside the more easily estimated costs and benefits. Other less tangible benefits may be more difficult to quantify, but should nevertheless be brought to management's attention. For example. reduced health maintenance costs. avoided future regulatory costs. and impmved relationships with regulators potentially affect the bottom line of the assessment.

"We wanted to make a major effort to show that industry in the US. can simultaneously attack and solve envùonmental problems while improving both products and profitability."

— John Dudek. value anaiysis manager at Zytec, as quored in perspectives on Minnesota Waste Issues. January-February 1992.

In time, as the movement toward green products and companies grows, as workers corne to expect safer working environments. and as companies move away from simply reacting to regulations and toward anticipating and addressing the environmental impacts of their processes and products. the less tangible

aspects of pollution prevention investments will become more apparent

EXPANDED TIME HORIZON

Many of the benefits of pollution prevention accrue over long periods of time.

Since many of the liability and less-tangible benefits of pollution prevention will occur over a long period of time, it is important that an economic assessment look at a long time frame, not the three to five years typically used for other types of projects. Of course, increasing the time frame increases the uncertainty of the cost factors used in the analysis.

LONG-TERM FINANCIAL INDICATORS

Net Present Value, Interna1 Rate of Return. and Profitability Index are useful financial indicators.

When making pollution prevention decisions, select long-term fmancial indicators that account for:

- all cash flows during the project
- the time value of money.

Three commonly used financial indicators meet these criteria: Net Present Value (NPV) of an investment , Internal Rate of Retum (IRR), and Profitability Index (PI). Another commonly used indicator. the Payback Period. does not meet the two criteria mentioned above and should not be used.

Discussions on using these and other indicators will be found in economic anaiysis texts.

DIRECT ALLOCATION OF COSTS

Developing a pollution prevention program may well provide the first real understanding of the costs of polluting.

Few companies allocate environmental costs to the products and processes that produce these costs. Without direct allocation, businesses tend to lump these expenses into a single overhead account or simply add them to other budget line items where they cannot be disaggregated easily. The result is an accounting system that is incapable of (1) identifying the products or processes most responsible for environmental costs, (2) targeting prevention opportunity assessments and prevention investments to the high environmental cost products and processes. and (3) tracking the financial savings of a chosen prevention investment. TCA will help you remedy each of these deficiencies.

Three methods of direct cost allocation:

- ***single pooling***
- ***multiple pooling***
- ***service centers***

Like much of the TCA method, implementation of direct cost allocation should be flexible and tailored to the specific needs of your company. TO help you evaluate the options available to you, the discussion below introduces three ways of thinking about allocating your costs: single pooling, multiple pooling, and service centers. The discussion is meant as general guidance and explains some of the advantages and disadvantages of each approach. Please see other EPA publications (such as those listed in Appen-

dix G), general accounting texts. and financial specialists for more detail.

Single Pool Concept

Single pool accounting is the easiest method. but it does not point up the effects of action within a given arëa.

With the single pool method. the company distributes the benefits and costs of pollution prevention across all of its products or services. A general overhead or administrative cost is included in all transactions.

Advantages. This is the easiest accounting method to put into use. All pollution costs are inc!uded in the general or administrative overhead costs that most companies already have, even though they may not be itemized as pollution costs. It may therefore not be a change in accounting methods but rather an adjustment in the overhead rate. No detailed accounting or tracking of goods is needed. Little additional administrative burden is incurred to report the benefits of pollution prevention.

Disadvantages. If the company has a diverse product or service line. pollution costs may be recovered from products or services that do not contribute to the pollution. This has the effect of inflaring the costs of those products or services unnecessarily. It also obscures the benefits of pollution prevention to the people who have the opportunity to make it successful – the line manager will not see the effect of preventing or failing to prevent pollution in his area of responsibility.

Multiple Pool Concept

Multiple pool accounting comes closer to tracking responsibility.

The nexf level of detail in the accounting process is the multiple pool concept., wherein pollution prevention benefits or costs are recovered at the department or other operating unit level.

Advantages. This approach ties the cost of pollution more closely to the responsible activity and to the people responsible for daily implementation. It is also easy to apply within an accounting system that is already set up for departmentalited accounting.

Disadvantages. A disparity may still exist between responsible activities and the cost of pollution. For example. consider a department that produces parts for many outside companies. Some customers need standard parts. while others require some **special** preparation of the parts. This special preparation produces pollution. Is it reasonable to allocate rhe benefit or cost for this pollution prevention project across all of the parts produced?

Service Center Concept

Service center accounting applies costs or benefits to the activities that are directlyresponsible.

A much more detailed level of accounting is the service center concept. Here, the benefits or costs of pollution prevention are allocated to only those activities that are directly responsible.

Advantages. Pollution costs are accurately tied to the generator. Theoretically, this is the most equitable to all products or services produced. Pollution costs can be identified as direct costs

in the appropriate contracts and not buried in the indirect costs. affecting competitiveness on other contracts. Pollution costs are more accurately identified, monitored and managed. The direct benefits of pollution prevention are more easily identified and emphasized at the operational Ievel.

Disadvantages. Considerable effort may be required to track each product. service. job, or contract and to recover the applicable pollution surcharges. Added administrative costs may be incurred to implement and maintain the system. It may be difftcult to identify the costs of pollution when pricing an order or bidding on a new contract. It may be difftcult to identify responsible activities under certain circumstances such as laboratoty services where many small volumes of waste are generated on a seemingly continual basis.

SUMMARY

Environmental costs have been rising steadily for many years now. Initially, these costs did not seem to have a major impact on production. For this reason, most companies simply added these *costs* to an aggregate overhead account. if they tracked them at all. The tendency of companies to treat environmental costs as overhead and to ignore many of the direct. indirect, and less-tangible environmental costs (including future liability) in their investment decisions has driven the development of TCA.

Expanding your cost inventory pulls into your assessments a much wider array of environmental costs and benefits. Extending the time horizon, even slightly, can improve the profitability of prevention investments substantially. since these investments tend to have somewhat longer payback schedules. Choosing long-term fmancial indicators. which consistently provide managers with accurate and comparable project financial assessments, allows prevention oriented investments to compete successfully with other investment options. Finally, directly allocating costs to processes and products enhances your ability to target prevention investments to high environmental cost areas, routinely provides the information needed to do TCA analysis. and allows managers to track the success of prevention investments. Overall, the TCA method is a flexible tool, to be applied incrementally. as your company's needs dictate.

TCA is an increasingly valuable rool ***as the business costs of pollulion continue to rise.***

APPENDIX F

Environmental Review Worksheets

Pollution Prevention **Worksheet 1**
Fruit & Vegetable Processors

Initial Activities

Company:	**Prepared by:**
Location:	**Date:**
Process Area:	**Sheet ___ of ___ Page ___ of ___**
Notes:	

Activity	Status: Complete? (Y/N)	Current? (Y/N)	Last Done	Notes
1. Secure Management Commitment				
. Is Board of Directors involved?				
. Is Board of Directors supportive?				
2. Define Policy Statement				
. Why?				
. What?				
. Who?				
3. Develop Employee Awareness				
. Circulate policy statement				
. Communicate P2 concept				
. Use newsletter				
. Involve/Motivate employees				
. Educate employees				
. Include P2 in new employee orientations				
. Compensate/reward employees				
4. Establish P2 Team				
. Representation from different departments?				
. Mix of technical, financial management & communication				
. Team leader?				
. Resources?				
5. Establish P2 Goals - Are goals:				
. specific, well defined?				
. clearly stated?				
. meaningful & useful?				
. quantitative/qualitative?				
. challenging?				
6. Establish Schedule & Budget				
. Are resources available? (people, time & money)				

Figure 5.1 Worksheet 1 - Initial Activities

Pollution Prevention **Worksheet 2**

Fruit and Vegetable Processors

Pre-Review Activities

Company:	**Prepared by:**
Location:	**Date:**
Process Area:	**Sheet ___ of ___ Page ___ of ___**

Description/Notes:

Activity	Status		
	Complete? (Y/N)	Date	Notes
1. Perform Preliminary Environmental Review			
. Determine sites? locations?			
. Determine priorities?			
. Determine areas of focus?			
2. Select Facility, Sites, or Process Area			
. For Environmental Review			
3. Select the Review Team			
. Multidisciplinary			
. Commitment to program			
. Team players			
. Creative thinkers			
4. Plan the Site Review			
. Agenda			
. Schedule			
. Availability of personnel			
. Resource needs (camera, sampling, etc.)			
. Orientation tour			
. Responsibilities of review team members			
5. Collect Background Information			
. Worksheets #3			
. Worksheets #4			
. Worksheets #5			
. Worksheets #6			

Figure 5.2 Worksheet 2 - Pre-Review Activities

Pollution Prevention **Worksheet 3**

Fruit and Vegetable Processors

Process Information

Company:	**Prepared by:**
Location:	**Date:**
Process Area:	**Sheet ___ of ___ Page ___ of ___**

Description/Notes:

Type of Operation:

___Continuous ___Discrete ___Batch/Semi-Batch ___Other(Specify)

Document	Status				
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Document Number	Location
1. Process Flow Diagram(s)					
2. Material/Energy Balance					
Design					
Operating					
3. Flow/Quantity Measurements					
Feed Stream(s)					
Product Stream(s)					
Residual Stream(s)					
Effluent Stream(s)					
4. Analytical Data & Documentation of Methods					
Feed Streams					
Product Stream(s)					
Residual Stream(s)					
Effluent Stream(s)					
5. Process Description					
Operating Manuals					
Equipment List					
Equipment Specifications					
Piping and Instrument Diagram(s)					
6. Layout/Elevation Plan(s)					
Work Flow Diagrams					
Hazardous Waste Manifests					
Emission Inventories					
Environmental Audit Reports					
7. Permit/Permit Applications					
Material Safety Data Sheets					
Inventory Records					
Operator Logs					
Production Schedules					
Other:					
Other:					
Other:					

Figure 5.3 Worksheet 3 - Process Information

Pollution Prevention **Worksheet 4**

Fruit and Vegetable Processors

Stream Mass Flow Data Sheet

Company:	**Prepared by:**
Location:	**Date:**
Process Area:	**Sheet ___ of ___** **Page ___ of ___**
Product:	**Description/Notes:**
Type of Operation: ___**Continuous** ___**Discrete** ___**Batch/Semi-Batch** ___**Other (Specify)**	
Reference Process Flow Drawing(s): PFD # ____ Date _____	

Stream No:															
Stream Name:															
Description:															
Duration:															
Identify Waste (Waste):															
Phase (Solid(S), Liquid(L) or Gas(G))															
Stream Data:	min.	norm.	max.	min.	norm.	max.	min.	norm.	max.	min.	norm.	max.	min.	norm.	max.
Total Flow (kg/hr):															
Product (kg/hr):															
Dry Ingredient_____ (kg/hr):															
Dry Ingredient_____ (kg/hr):															
Wet Ingredient___(Oil)__ (kg/hr):															
Wet Ingredient_____ (kg/hr):															
Other (kg/hr):															
Other (kg/hr):															
Waste Product (kg/hr):															
Water (kg/hr):															
TSS (kg/hr):															
BOD (kg/hr):															
COD (kg/hr):															
O&G (kg/hr):															
Cleaning Agents (kg/hr):															
Sodium Hypochlorite (kg/hr)															
Detergent (kg/hr):															
Other (kg/hr):															
Physical:															
pH:															
T (deg.C):															
P (kPa(g)):															
Size:															
Operating:															
Operating Hours/Day:															
Operating Days/Year:															

Figure 5.4 Worksheet 4 - Stream Mass Flow Data Sheet

Pollution Prevention **Worksheet 5**

Fruit & Vegetable Processors

Transport/Financial Information

Company:	**Prepared by:**
Location:	**Date:**
Process Area:	**Sheet ___ of _ Page ___ of ___**

Description/Notes/Reference Drawings:

Type of Operation:

___Continuous ___Discrete ___Batch/Semi-Batch ___Other(Specify)

Stream No.:			
1. Stream Data:			
Stream Name:			
Description:			
Feed(F)/Product(P)			
Phase (Solid(S), Liquid(L), Gas(G))			
2. Flow Data:			
Stream Hourly Flow (kg/hr)			
Operating Hours/Day			
Operating Days/Year			
Stream Yearly Flow (tonne/year)			
3. Financial:			
Unit <Cost>/Revenue $/tonne			
Annual <Cost>/Revenue $/year			
4. Transportation/Handling:			
Shipping Mode (truck, etc.)			
Shipping Container Type			
Size (Bag, Box, etc.)			
Storage Mode (Outdoor, Warehouse, etc.)			
Transfer Mode (Forklift, Conveyor, etc.)			
Cost of transportation ($/year):			
5. Input Materials Summary:			
Supplier would:			
- accept expired material? (Y/N)			
- accept shipping containers? (Y/N)			
6. Products Summary:			
Are Containers Returnable? (Y/N)			
Customer Would:			
- accept expired material? (Y/N)			
- accept shipping containers? (Y/N)			
- relax specification? (Y/N)			
- accept larger containers? (Y/N)			

Figure 5.5 Worksheet 5 - Transport/Financial Information

Pollution Prevention **Worksheet 6**

Fruit & Vegetable Processors

Waste Stream - Compliance / Prioritization

Company:	**Prepared by:**
Location:	**Date:**
Process Area:	**Sheet ___ of ___ Page ___ of ___**
Notes:	**Reference Drawings:** **Type of Operation:** **___Continuous ___ Discrete** **___ Batch/Semi-Batch ___Other (Specify)**

Stream No.:						
1. Waste Stream Data:						
Stream Name:						
Description:						
Phase (Solids(S), Liquid(L)):						
2. Quantity Data:	Normal	Permit	Normal	Permit	Normal	Permit
Volume Flow (m3/d)						
Mass Flow (kg/d)						
BOD (mg/L)						
BOD (kg/tonne product)						
TSS (mg/L)						
TSS (kg/tonne product)						
pH						
Other:						
Other:						
Other:						
3. Disposal Information:						
Disposal/Discharge Method:						
Permitted by:						
Unit Cost ($/kg or m3)						
Yearly Cost ($/ year)						

	Relative Wt. (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
4. Priority Rating Criteria (see Note)							
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating							
Priority Rank							

Note: Assign relative weights (W) to criteria depending on importance and then rate (R) each stream in each category on a scale from 0 (none) to 10 (high).

Figure 5.6 Worksheet 6 - Waste Stream - Compliance Prioritization

Pollution Prevention **Worksheet 7**

Fruit & Vegetable Processors

Option Generation

Company:	**Prepared by:**
Location:	**Date:**
Process Area:	**Sheet ___ of ___**
Notes:	**Meeting Format:**
	Meeting Coordinator:
	Meeting Participants:

List Suggested Options	Rationale/Remarks on Option	Action
* List is not exhaustive and may be used as a guide to prompt other options.*	Currently Done Y/N	
1. Raw product washing		
First wash followed by second wash		
Final wash		
Countercurrent with water treatment		
2. Fluming		
Fluming of un-washed product		
Fluming of prepared product		
Fluming of solid residuals		
3. Blanching		
IQB blanching		
Steam blanching		
Replacement of make-up water		
4. Washing totes, flats, trays, etc.		
Tank washers & recycled, treated water		
Spray with make-up water		
5. Cooling water		
Countercurrent cooling		
Cooling water to wash line		
6. Plant sanitation		
Preliminary dry pick-up		
Preliminary wash-down with recycled water		
7. Mechanical systems		
Compressor cooling water recycle		
Packaging machine cooling water recycle		
8. Other Options		

Figure 5.7 Worksheet 7 - Option Generation

Pollution Prevention **Worksheet 8**

Fruit & Vegetable Processors

Option Description and Economic Analysis

Company:	**Prepared by:**
Location:	**Date:**
Process Area:	**Sheet ___ of ___**
Notes:	**Meeting Format:**
	Meeting Coordinator:
	Meeting Participants:

Option Description	Cost Analysis	
	Capital Costs	
	Purchased Equipment	
	Materials	
	Installation	
	Utility connections	
	Engineering	
	Start-up and training	
	Other	
	Total Capital Costs, C:	
	Incremental Annual Operating Costs	
	Change in disposal costs	
	Change in utility cost	
	Change in raw material cost	
	Change in labour cost	
	Change in other costs	
	Annual Net Operating Cost Savings, S:	
	Simple payback period (in years), C/S:	
	Total Cost Analysis Approach	
	Long-term liabilities	
	Fines	
	Penalties	
	Personal damages	
	Property damage	
	Site remediation	
	Clean-up costs	
	Enhanced corporate image	
	Marketing benefits	
	Improved relationships in community	
	Improved employee morale and performance	
	Other indirect benefits	

Figure 5.8 Worksheet 8 - Option Description and Economic Analysis

Pollution Prevention **Worksheet 9**

Remaining Activities

Company:	**Prepared by:**
Location:	**Date:**
Process Area: N/A	**Sheet ___ of ___ Page ___ of ___**

Activity	Status			
	Complete? (Y/N)	Current? (Y/N)	Last Done	Notes
1. Collect Necessary Data				
. Preliminary review?				
. Detailed review?				
2. Confirm Compliance/Priorities				
. Is facility in compliance?				
. Are waste streams prioritized for further review or P2 option?				
3. Identify P2 Opportunities				
. Best management practices				
. Reduce, reuse, recycle				
. Best available technology				
. Conservation				
. Equipment, operations, procedures				
. Process changes, material, substitution				
4. Evaluate P2 Opportunities				
. Technical				
. Environmental				
. Economic (capital, operating)				
5. Implement P2 Opportunities				
. Select projects				
. Obtain funding				
. Install				
6. Measure Progress				
. Aquire data				
. Analyze results				
7. Maintain and Improve P2				
. Review program annually or bi-annually				
. Revise as required				
. Repeat annually or bi-annually				
. Integrate with corporate planning				
. Provide ongoing employee education				
. Maintain internal communication				

Figure 5.9 Worksheet 9 - Remaining Activities