RASER RIVER
ACTION PLAN

Technical Guide For The Development Of Pollution Prevention Plans For Fish Processing Operations In The Lower Fraser Basin

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TECHNICAL GUIDE FOR THE DEVELOPMENT OF POLLUTION PREVENTION PLANS FOR FISH PROCESSING OPERATIONS IN THE LOWER FRASER BASIN

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Prepared for:

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DISCLAIMER

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ABBREVIATIONS

BOD	Biochemical Oxygen Demand
CCME	Canadian Council of Ministers of the Environment
DFO	Department of Fisheries and Oceans
GVS&DD	Greater Vancouver Sewerage and Drainage District
MOELP	Ministry of Environment, Lands and Parks
NPV	Net Present Value
O&G	Oil and Grease
P2	Pollution Prevention
SIC	Standard Industrial Classification
TSS	Total Suspended Solids

GLOSSARY

Aquaculture	Husbandry of aquatic animals.
Biochemical Oxygen Demand	Oxygen required for the biochemical degradation of organic material in wastewater as measured by standardized empirical tests.
Busses	Slatted metal baskets with movable bottoms for storage of cans during pressure cooking.
Contaminant Loading	Total mass of a contaminant discharged during a certain peroid of time, generally one hour or one day.
Dressing	Process of butchering fish.
Grease and Sand Interceptor	A grease and sand interceptor allows heavy solids, such as sand, to settle while preventing floatable material, such as grease, from entering the effluent pipe.
Hydrolysate	Liquified (fish) protein. Liquification may be accomplished by acids or protein-digesting enzymes following the mincing and grinding of fish parts or whole fish.

Milt	Sperm of male fish or the sperm filled reproductive organ or a male fish
Net Present Value	The difference between the discounted, or present, value of the future income and the amount of the initial investment.
Normalization	Process of expressing data on a common basis.
Normalized Contaminant Loading	Contaminant loading divided by a normalization factor, generally the weight of fish processed during the time for which the loading was determined.
Offal	Unedible parts of fish or edible parts which became unedible due to their treatment, for example edible parts which have dropped onto the floor.
Patching	Adding fish to underweight cans.
Pelagics	Midwater-dwelling fish.
Popping	Removing roe from fish.
Retorte	Large pressure cookers for cooking cans.
Roe	Fish eggs.
Round Fish	General term for unprocessed fish.
Sexeors	Equipment to allow the sorting of fish by their sex.
Tote	Large rectangular containers for intermediate storage and transport of fish, whicn are generally made of plastic or aluminum.
Trolling	Fishing by drawing bait through water.

1 INTRODUCTION

1.1 REPORT STRUCTURE

The Guide for the Development of Pollution Prevention Plans for Fish Processing Operations in the Lower Fraser Basin (Guide) is structured into the following four sections:

- Section 1: presents the objectives of the Guide;
- Section 2: provides a general overview of the industry;
- Section 3: presents the necessary background information for fish processing plant personnel to develop facility specific pollution prevention plans, including how to identify areas of environmental concern, and pollution prevention options available to fish processing plants in general;
- Section 4: is a "How To" description for developing facility specific pollution prevention plans. The section provides worksheets along with a description for their use for conducting all phases in the development and assessment of a pollution prevention plan.

1.2 OBJECTIVES OF THE GUIDE

This Guide is designed to provide the fish processing industry located in the Lower Fraser Basin with a step-by-step procedure to develop facility-specific pollution prevention plans. It includes worksheets for use in the evaluation of the pollution prevention potential at a particular facility and suggests pollution prevention options appropriate to the industry. The document covers actions related specifically to fish processing operations and does not include pollution prevention activities applicable to support activities such as administration and plant maintenance. Such activities may be included in a comprehensive facility pollution prevention exercise. The Guide considers both liquid and solid wastes associated with fish processing. The document is designed for use by plant operators but it can also be useful to regulatory agencies, industry suppliers and consultants.

The Guide is based on Environment Canada's "Guide for the Best Management Practices for Process Water Management at Fish Processing Plants in BC" (NovaTec, 1994a), and "Reference Workbook: Pollution Prevention Plan" (PCA, 1994).

1.3 POLLUTION PREVENTION POLICY

In June, 1995, Environment Canada defined in "Pollution Prevention, A Federal Strategy for Action" that pollution prevention is:

> "The use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and waste, and reduce overall risk to human health or the environment."

In support of pollution prevention initiatives, the BC Ministry of Environment, Lands and Parks (MOELP) and the Fraser Pollution Abatement Office have taken steps to encourage industries to reduce pollutants discharged to the environment through the implementation of pollution prevention plans (PCA, 1994).

MOELP has developed the following hierarchy for a pollution prevention planning exercise (British Columbia Ministry of Environment, Lands and Parks 1995):

- avoidance, elimination or substitution of polluting products;
- reduction in the use of pollution products;
- elimination and/or the reduction in the generation of pollution by-products; and
- re-use and recycling of polluting by-products.

and if necessary:
- treatment and containment of polluting residual by-products; and
- remediation of contaminated sites.

1.4 BENEFITS OF POLLUTION PREVENTION

Pollution prevention is beneficial as the separation and/or conversion of materials, which is the most general description of wastewater treatment, is generally much more expensive than the implementation of processes and procedures which prevent the mixing of the materials in the first place. In the case of fish processing plants, pollutants contained in wastewater consist of solids and dissolved materials. Of these, only relatively large solids are easily and inexpensively removed. Removal of dissolved materials and very small solids, both of which contribute substantially to the total contaminant load from fish processing facilities, generally requires sophisticated and costly equipment. Therefore, pollution prevention activities which prevent such materials from entering wastewater or minimize their concentration represent direct economical benefits for processing plants.

MOELP further lists the following potential benefits as a result of implementing effective pollution prevention plans (British Columbia Ministry of Environment, Lands and Parks, 1995):

- increased value of products, increased process efficiency, and reduced overall facility operating costs;
- improved trading opportunities in the global market;
- provision for proactive environmental protection;
- balanced decisions affecting land, air and water;
- integration of regulatory permits for several discharges into one approval;
- protection of employee & public health;
- improvement of employee morale, teamwork and participation;
- enhancement of corporate image in the community;
- reduction of risk of criminal and civil liability ; and
- development of partnerships with other facilities and stakeholders.

1.5 PLANNING AND ORGANIZATION PHASE

Essential elements of planning and organization for a waste minimization program are: obtaining management commitment for the program, setting waste minimization goals and organizing an assessment program (USEPA, 1991). The assessment phase involves a number of steps such as (USEPA, 1991):

- Collect process and site data: the waste streams at a facility should be identified and characterized. Developing a basic understanding of the processes that generate waste at a facility is essential.
- Prioritize and select assessment targets: ideally, all waste streams in a facility should be evaluated for potential waste minimization opportunities. Considerations such as quantity of waste, hazardous properties of the waste, regulations, safety of employees, economics and other characteristics need to be evaluated in selecting a target stream.

- Select assessment team: the team should include people with direct responsibility and knowledge of the particular waste stream or area of the plant.
- Review data and inspect site: the assessment team evaluates process data in advance of the inspection. The inspection should follow the target process from the point where raw materials enter the facility to the points where products and waste leave. The team should identify the suspected sources of waste.
- Generate options: generate a comprehensive set of waste minimization options for further consideration.
- Screen and select options for feasibility study: select the most promising options for full technical and economic feasibility study.

1.6 FEASIBILITY ANALYSIS PHASE

An option must be shown to be technically and economically feasible in order to merit serious consideration for adoption at a facility. Both process and equipment changes need to be assessed for their overall effects on waste quantity and product quality (USEPA, 1991). In this Guide, an option is considered economically feasible if its net present value (determined as described in the Guide) is positive.

1.7 IMPLEMENTATION PHASE

An option that passes both technical and economic feasibility reviews should then be implemented at a facility. Tracking the waste and identifying further opportunities for waste minimization should be carried out periodically (USEPA, 1991).

2 INDUSTRY PROFILE

2.1 SEAFOOD AND MARINE PRODUCTS BRITISH COLUMBIA

Canadian fish products are harvested from oceans off Canada's Atlantic and Pacific coasts as well as from inland freshwater lakes. These three fisheries are based chiefly on groundfish, pelagics, salmonides, molluscs, crustaceans and freshwater fish.

The Canadian seafood and marine products industry is a major world exporter of such products. It provides hundreds of small communities with an important source of jobs and resources. Statistics Canada estimates that in 1990 there were 460 fish processing establishments in Canada employing 27,617 people, with 57 establishments (not including small enterprises) in B.C. employing 4,388 people. Other estimates include smaller companies, and put the number of fish processing plants in B.C. at 173 facilities (NovaTec, 1994). Table 1 presents a summary of BC fisheries resources.

Table 1: Economic Summary of BC Fisheries Resources

West Coast	**1990**	**1991**	**1992**	**1993**
Wholesale value ($ millions)	948	762	788	906
Landed value ($ millions)	480	381	417	440
Landings (10^3 tonnes)	302	316	299	280

Source: The 1993 British Columbia Seafood Industry Year in Review (Ministry of Agriculture, Fisheries and Food, 1994a)

B.C. fish processing in 1990 accounted for 12 % of the total number of Canadian fish processing plants, 16 % of total industry employment, and 32 % of the landed value, making it the largest fishing province in Canada (Ind. Sci. and Tech. Canada, 1991a).

The British Columbia fishing fleet was comprised of 5,773 and 5,915 vessels in 1990 and 1992, respectively (NovaTec, 1994a).

Commercial fishing is the fourth largest primary industry in British Columbia after forestry, mining and agriculture. The fish processing sector accounts for over 25 % of all food manufacturing activity in the province (B.C. Ministry of Agriculture, Fisheries and Food, 1992). In 1990, approximately 70 % of the total value of fish products originated from the Lower Mainland region, and 18 % in the Prince Rupert area with the Vancouver Island and the Sunshine Coast regions contributing 9 and 3 % respectively (B.C. Ministry of Agriculture, Fisheries and Food, 1992).

The west coast fish processing industry is highly export-oriented. More than 50 % of salmon products and all herring roe are exported. About two-thirds of the groundfish and most of the shellfish products are exported as well (Ind. Sci. and Tech Canada, 1991 b). The United States is the principal market for groundfish and shellfish. The United Kingdom accounts for half of the canned salmon exports, and Japan accounts for about 40 % of the frozen salmon exports and virtually all of the herring roe production (Ind. Sci. and Tech. Canada, 1991b).

Development of aquaculture (husbandry of aquatic animals) in recent years in Canada may lead to a year-around operation in the fish processing industry.

2.2 RAW MATERIALS

The west coast seafood and marine products industry process primarily pelagic fish or mid-water dwellers such as salmon and herring. Groundfish or bottom-feeding fish such as halibut, redfish and hake, and shellfish including clams, oysters, shrimps and crabs make up most of the balance. Fish processing is concentrated in the Lower Mainland of B.C., Vancouver Island, and around Prince Rupert.

Fish processing is highly seasonal, as fish are only caught when they are in prime harvest condition. In addition, some species such as salmon are migratory. The harvest of most coast salmon species occurs from late June until October - November. Pacific salmon includes six commercial species: sockeye, chinook, chum, coho and pink which form the basis of the west coast salmon fishery, and cherry salmon which is harvested only in the vicinity of Japan. Spring, coho and some pink and sockeye salmon are caught using trolling techniques, whereas the remaining species of salmon are netted. Troll caught salmon are gutted at sea and stored on ice, or frozen at sea.

The roe herring harvest takes place principally in March, just before the herring are about to spawn. The main product of herring processing in the B.C. Lower Mainland is cured herring roe. However some processing of herring caught in the fall does occur.

2.3 PROCESSING DESCRIPTION

The two major types of fish processing in the Lower Fraser Basin are salmon processing and roe herring processing. Ground fish and shellfish processing represent a minor contribution to all fish processing in the Lower Fraser Basin.

Each group has a unique production process. Variation in processing procedures are found from plant to plant, but the major features of salmon and herring production are quite consistent and are discussed in the following sections.

2.3.1 Vessel Unloading

Vessel unloading is common to all fish processing. It can be done with wet (siphon) or dry (vacuum) pumps, or with buckets or baskets. Dry pumps result in rough handling of the fish and are generally only used for ground fish due to the relatively low commercial value of the fish. Wet pumps are much gentler and are used for freshly caught herring and salmon which are kept in water inside the holds of fishing boats and fish packer vessels during transport. The pumps use large diameter hoses to pump water and whole fish out of the vessels' holds. Water and fish are then discharged onto grating to allow the separation of fish and water. A certain amount of water is recirculated to the vessels to ensure sufficient water for the operation of the pumps and to be able to remove all fish. The water level in the vessel is continually lowered during the unloading operation and the vessel, generally, is almost completely empty when all fish have been unloaded.

Conveyors pick up the fish after their separation from the vessel hold water and transport them to sorting stations. In the case of salmon, the fish are manually sorted according to their species and quality. After sorting, fish are kept in chilled water or ice for intermediate storage until they can be further processed. Grading is not required for herring.

Baskets or buckets can also be used to unload vessels but are, generally, only used if small quantities of fish need to be unloaded, or to offload frozen fish. In these cases baskets are lowered into the vessels holds by a crane and filled with frozen fish.

2.3.2 Transport

Fish transport within fish processing plants is generally by conveyor or, if stored in totes, by fork lift. Frozen roe herring is generally trucked off-site for cold storage and processed after the roe herring fisheries are closed.

2.3.3 Intermediate Storage

Intermediate storage of the herring may be required, as the capacity of the vessel unloading pumps may exceed the throughput of subsequent handling steps. To prevent spoilage, fish are stored in chilled water or directly on ice. Reuse of the chilled water for fish storage is sometimes practised as an energy and water conservation measure.

2.3.4 Dressing

Dressing is only carried out with salmon (halibut and some salmon are dressed at sea). Dressing fish for freezing involves the removal of the head and gutting of the fish. The tails, fins and the collar bone immediately behind the head are not cut off. The eggs (or roe) of the female fish are removed for further processing, and the milt of the male is removed at this stage.

Dressing for freezing is done manually or with semiautomatic dressing lines. The manual dressing lines consist of a large table and fish cleaning station, where workers are responsible only for specific tasks, such as:

- head removal
- belly slitting
- removal of viscera and separation of milt and/or roe
- removal of the kidney
- cleaning of fish

The final cleaning of the fish is done with a spoon which is directly attached to a small water hose ("wet spoons") to both scrape and flush remaining viscera and blood away.

Offal from dressing tables may be dropped on the floor, into totes for collection, or chutes which discharge to a flume or dedicated offal conveyance system.

On the semi-automatic processing lines, fish are placed belly up in a pocket conveyor after their heads have been removed. Head removal can be achieved manually or automatically. The bellies are then slit manually; guts, and roe or milt are removed by hand and separated for waste disposal or further processing, followed by the cutting of the kidney. Cleaning of the fish of remaining guts and blood is accomplished with vacuum hoses and, finally, with spoons attached to small water hoses as in the case of manual cleaning. The dressed fish are then washed, graded, and frozen.

Salmon may also be dressed for canning (generally done with an iron butcher which cuts off heads including the collar bone, tails and fins). Although the iron butcher can be used to slit and remove the viscera, this is usually done by gutting and washing machines which results in better cleaning. Entrails are removed with rotating wheels and brushes and stationary water sprays rinse the belly cavity. Final cleaning is with water sprays. The wash water, mixed with guts and blood, drains out at the bottom of the gutting machines. After dressing the fish are inspected and are manually cleaned if necessary. Cleaning is with "wet spoons" as outlined above.

2.3.5 Freezing and Glazing

Salmon are generally blast frozen either in tunnels or on racks. Frozen salmon (and halibut) then receive a smooth coating of clear ice glaze prior to final packing and shipping. This glazing is accomplished by either spraying already frozen fish with a fine water spray, or by dipping the frozen fish into chilled water. After glazing the frozen fish are packed in plastic bags and placed in boxes for shipment.

Roe herring are frozen to preserve fish shape and quality of the roe. Freezing also allows roe herring processing to take place at a steady pace after the relatively short fishing season is over. Generally herring freezing takes place in brine freezing channels which contain a saturated sodium chloride solution at -18°C followed by tunnel freezing to rapidly freeze the individual fish. The frozen fish are kept in cold storage until further processing.

2.3.6 Canning

Fish, dressed for canning as described in Section 2.3.4, is fed into filling machines which cut the fish into sections of appropriate size for the cans to be used in the canning machines. Canning machines then press the fish sections into cans which are subsequently inspected by workers who rearrange the material in the cans for aesthetic purposes and add additional material to under-weight cans (patching), if necessary. Lids are then lightly clinched onto the cans, and the cans are sealed in the seamers which operate under vacuum.

Following the sealing, the cans are washed and placed in busses (slatted metal baskets with movable bottoms) and pressure cooked in large retorts. After the cooking process the cans are cooled with water which must exhibit a chlorine concentration of 0.5 mg/L at the outlet of the retorts. Therefore, the water is generally chlorinated to a concentration of 5 mg/L for 20 minutes to ensure disinfection.

2.3.7 Roe Processing

The roe collected during salmon dressing (dressing for freezing or canning) is further processed by washing and curing in a concentrated brine solution for 20 minutes. Washing and curing takes place in agitated, circular tubs. The brine is replaced after each five batches of roe processed.

Herring roe processing requires thawing of the frozen herring and "popping" of the roe. Herring may be thawed in water, air, or a combination of both. Air thawing is substantially more labour intensive than water thawing and requires placing the frozen herring on racks for thawing. Air thawing also generates wastewater, as the thawed herring are generally stored in water until roe popping takes place. Water thawing involves holding frozen fish in tanks of overflowing water. Overflow is essential to keep heat coming into the system, but it consumes large quantities of water which cannot be recycled.

When the thawing process is complete and the roe is firm, the fish are separated from the tote water using tote dumpers. Conveyors then transport the fish to popping stations for removal of the roe from the female fish. At manual popping stations the fish are broken open, and the roe removed and collected. The fish carcasses are collected separately.

Automatic roe popping machines which only require the fish to be manually placed on an infeed belt are also available. These machines also separate the roe from the milt of the male herring, although this separation is not without errors, and further manual separation of milt from roe and vice versa is required. The milt is collected with the carcasses and generally is directly transported to offal hoppers.

The roe from manual and/or automatic popping is rinsed with water, and washed and cured in diluted brine, followed by the curing of the roe in concentrated brine for four to seven days. After curing, the roe is manually graded, packed in pails to which concentrated brine and salt is added, and shipped.

2.3.8 Milt Processing

Milt processing only involves washing the milt in water and freezing prior to shipping. Only salmon milt is processed.

2.3.9 Farm Fish Processing

Farm salmon processing differs from wild salmon processing because farm salmon can be transported live to processing facilities. This allows bleeding-out of the fish prior to processing which improves shelf life, appearance and quality. Farm salmon are mainly processed for the fresh fish market.

After live-hauling to a processing facility, the fish are removed from the water with a wet pump, cut behind the gill arch on one side of the head and placed in water-filled totes for bleeding. Further processing consists of eviscerating, cleaning and washing which is generally done manually with or without vacuum suction as described in Section 2.3.4. Fins and tails are not removed and the heads are generally not cut off.

2.3.10 Smoked Fish (Salmon and Black Cod)

Fish for smoking are generally prefrozen. Frozen products for smoking are frequently thawed in tanks of overflow water. Overflow is essential to keep heat coming into the system but consumes large quantities of water, which cannot be recycles. When thawing is complete, the fish are further processed, cured and smoked.

2.4 PRODUCTS

Fish processing plant products (defined as the main product of each fish processing operation) in the Lower Fraser Basin mainly consist of the following:

- Herring roe;
- Salmon milt;
- illeted groundfish and salmon;
- Marinated herring;
- Smoked salmon;
- Canned fish;
- Frozen fish;
- Fresh fish; and
- Live products such as crab and lobster, bi-valve molluscs and shrimp processing/peeling.

2.5 BY-PRODUCTS

In this report, by-products are defined as saleable materials which are generated or become available as a result of the processing required to produce the main product of a facility. For fish processing plants of the Lower Fraser Basin this includes the following:

- Salmon roe;
- Salmon milt;
- Fish heads; and
- Offal.

It should be pointed out that offal may not only be considered a by-product (as it is generally sold to reduction plants or to pet and mink food producers, see Section 2.6.3), but also a waste material, particularly in very small operations which sometimes freeze offal for subsequent landfilling.

2.6 WASTE MATERIALS

2.6.1 Types

Mainly two types of wastes are produced at the fish processing facilities:

- Liquid waste
- Solid waste

The origins of these types of wastes are addressed in the following sections. With the exception of salmon canning (air emissions due to the combustion of fuel for steam generation for the operation of retorts) and operating smoke houses, fish processing does not result in air emissions. Air emissions are beyond the scope of this Guide.

2.6.2 Waste Stream Origins

Generally, wastewater is generated at fish processing facilities from a variety of processes, such as:

- Unloading of boats;
- Intermediate fish storage;
- Fish cleaning;
- Fish transport (for example in wet pumps and fluming);
- Fish freezing;
- Fish thawing;
- Preparation of brines;
- Equipment sprays;
- Offal transport;
- Cooling water; and
- Equipment and floor cleaning.

Most of these sources (or water uses) have been addressed in Section 2.3 and are inherently connected to the particular type of fish processing taking place at individual facilities, such as the use of cooling water for fish canning. Certain wastewater streams such as those generated by the spraying of fish and product conveyors are the result of regulatory requirements for sanitation purposes. Permanently installed water sprays are generally used to keep automated processing equipment clean, to reduce bacterial loading on contact surfaces, for lubrication and to flush away offal.

Typically, large chunks of offal (heads, tails, fins, etc.) fall into chutes which direct the offal to flumes, or are washed into flumes, which transport the offal to a collection sump. However, a certain amount of offal generally falls onto the floor where it accumulates and must be removed manually. This is typically done by hosing the offal into a nearby drain or flume.

Apart from resulting in high water consumption, this method of equipment cleaning and offal transport causes the mixing of the rinse water with offal and blood, which has two main disadvantages:

1) Any soluble BOD components (i.e. blood) will be dissolved in the water. Dissolved BOD cannot be removed by physical treatment such as screening.

2) The wastewater pumping action is rough on offal chunks resulting in an increase of smaller particles which may pass through the following screen. In addition, pumping is believed to increase the dissolved BOD content by solubilizing suspended organic material.

2.6.3 Solid Waste Generation

Generally, solid waste (offal) is generated from the following processes at the fish processing plants:

- Vessel unloading;
- Fish dressing (or butchering);
- Fish cleaning;
- Canning; and
- Roe popping

Generally, offal generated in fish processing facilities is used as a feed material to other industries such as mink food, fish meal and fish oil manufacturing. A recent review of fish waste management practices in B.C. estimated that 85 - 90% of all offal generated in B.C. is utilized for value added products (NovaTec, 1994a). Utilization of offal from fish processing companies located on the lower Fraser River reaches virtually 100% (NovaTec, 1994b). Therefore, offal disposal or utilization does not represent a problem for fish processing plants of the Lower Fraser Basin.

2.6.4 Pollutants of Concern

2.6.4.1 Liquid Waste

Pollutants of concern in the fish processing industry include the following:
- Biochemical oxygen demand (BOD);
- Total suspended solids (TSS);
- Oil and grease (O&G);
- Ammonia; and
- Chlorine residual.

BOD refers to the amount of oxygen required by bacteria when breaking down the waste. Generally, BOD is due to dissolved and suspended organic waste materials. The dissolved fraction includes blood which has a very high BOD (100,000 to 250,000 mg/L) and which readily dissolves in water. (For this reason blood should be prevented from mixing with water whenever possible.)

TSS in fish processing wastewater is mainly of organic origin and, therefore represents a measure of the amount of BOD which is due to suspended rather than dissolved material. O&G refers to the amount of oil, fat, and grease dissolved or emulsified in the wastewater. Ammonia originates from blood and slime. Chlorine is used to disinfect equipment and cooling water in canneries. Many plants use vastly too much chlorine in their disinfection program (50 ppm is suggested as an optimum target concentration to be used).

Wastewater characteristics vary substantially with the type of species processed, applied processing technology and type of finished product. Most of the BOD and TSS and up to 60 % of oil and grease originates from the butchering process (NovaTec, 1993a). Generally, lower BOD and ammonia nitrogen concentrations can be expected from shellfish processing.

2.6.4.2 Solid Waste

As described in Section 2.6.3, fish offal generated in processing facilities in the Lower Fraser Basin is generally recycled. Therefore, solid waste management does not represent a concern.

2.6.5 Hazardous Properties

Liquid and solid wastes generated at fish processing plants are not considered hazardous. However, liquid waste may be toxic to fish in standard fish toxicity tests such as the 96-hour rainbow trout LC50 Test. In a recent study of effluents from fish processing plants located on the lower Fraser River, fish toxicity of the effluents was attributed mainly to low dissolved oxygen levels (NovaTec, 1994b). Chlorine, which is toxic to fish, was also detected in some of the effluent samples (maximum concentration detected: 0.15 mg/L).

2.7 CURRENT WASTE MANAGEMENT METHODS

Wastewater generated at fish processing facilities in the Lower Fraser Basin is typically screened and immediately discharged to the receiving environment or sewer system. Screening is generally a two step process involving coarse screening, typically with a dewatering conveyor to remove large chunks of offal, followed by fine screening. The latter may be provided by rotary or sidehill screens located in the processing plant or outdoors. Large offal and screenings are typically stored in outdoor hoppers until they are picked up by truck for further processing and as feed material in other industries.

The majority of the fish processing facilities located in the Lower Mainland discharge their wastewater to the sewer and only two of the larger facilities discharge to the environment (NovaTec, 1994a). The status of treatment for plants discharging to sewer was reviewed for those located in the Greater Vancouver Sewerage and Drainage District (GVS&DD). The level of treatment ranges from the use of grease and sand interceptors to screening (30 % and 80 % of all plants, respectively). Approximately 10 % of these facilities use a combination of the two forms of treatment.

Permits issued by the MOELP were also reviewed to determine the status of treatment in place for effluent discharges to the environment. Effluent treatment at fish processing plants discharging into the environment generally involve screening. The most common mesh size in use is 25 mesh (0.6 mm). Fish processors currently do not implement any further treatment of the effluent besides screening (NovaTec, 1994a).

2.8 REGULATORY REQUIREMENTS

2.8.1 Applicable Permits

Discharge of wastewater from a fish processing facility is regulated by municipal sewer bylaws if the facility is discharging into a sewer system, or by MOELP if the facility is discharging directly into the environment. Air emission permits are required for salmon canneries operating fossil fuel powered boilers and for smoke houses in the Greater Vancouver Regional District (GVRD).

2.8.1.1 Wastewater Discharge to Sewer

The individual discharge permits require treatment of the effluent prior to discharge to sewer. Generally, the screen sizes used in plants discharging to the sewer is not specified in the permit. Permits typically specify the maximum flow that could be discharged, and maximum BOD, TSS and oil and grease concentrations.

2.8.1.2 Wastewater Discharge to Environment

Wastewater discharge to the environment is regulated by MOELP permits. The permits generally specify the type of wastewater treatment required but do not include contaminant concentration limits with the exception of the chlorine concentration in effluents from salmon canneries, which must be below 0.05 mg/L. Generally the maximum discharge rate is identified and screening of the effluent prior to discharge is required.

The federal Fisheries Act prohibits the deposit of deleterious substances into waters that support fish. 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...". To meet this specification, effluent should be non-acutely lethal to fish. Requirements for other effluent constituents such as BOD and TSS may be prescribed by Environment Canada to protect receiving water quality.

2.8.2 Discharge Data

Typical ranges of BOD, TSS, and oil and grease concentrations from fish processing at B.C. fish processing facilities are presented in Table 2 (NovaTec, 1994a).

2.8.3 Performance

Fish processing plants discharging into the sewer system (GVS&DD) generally comply with the permit requirements. A new GVS&DD surcharge fee structure for facilities discharging to sewer is expected to be in place in early 1996 and may affect contaminant concentration limits and the ability of processing plants to meet the criteria.

The fish processing plants discharging into the environment generally comply with their permit requirements (maximum discharge flow and screening).

Table 2: Typical Ranges of Contaminant Concentrations in Fish Processing Plant Effluents - B.C. Lower Fraser Basin

Species Processed	Parameter		
	BOD (mg/L)	TSS (mg/L)	O&G (mg/L)
Salmon	20-2,680	11-2,180	1.5-490
Salmon/Groundfish	150-1,000	20-290	2-180
Groundfish	35-370	45-195	18-80
Groundfish/Halibut	165-1,670	28-960	8-100
Herring	20-1,745	25-400	6-75

2.8.4 Plant Sanitation Requirements

Requirements for fish plant construction, operation and maintenance, including plant clean-up and sanitation, potability of process water, and product quality and sanitation, are contained within the federal *Fish Inspection Act* and *Regulations* and within the *British Columbia Fish Inspection Act* and *Regulations*. In addition, fish processors registered under the federal *Fish Inspection Act* and *Regulations* are required to develop and operate a Quality Management Program (QMP) for their plant operations. The QMP must be approved by the Department of Fisheries and Oceans, and includes process and procedures for plant clean-up and sanitation, and product handling.

3 POLLUTION PREVENTION AND WASTE MINIMIZATION

3.1 GENERAL

In the case of liquid waste, there are two aspects to pollution prevention and waste minimization:

- reduction of contaminant concentrations; and
- reduction of contaminant loadings.

Contaminant concentrations refer to the mass of a contaminant contained in a certain volume of wastewater, whereas contaminant loading refers to the total mass of the contaminant generated or discharged during a certain amount of time, (i.e. per day).

While the contaminant concentration can be reduced by increasing water consumption, resulting in a dilution of the waste stream, the contaminant loading is not affected by such measures. Alternatively, a reduction of the water consumption, everything else being equal, only raises the contaminant concentration but not the loading. However, if the water conservation measures also result in a reduction of the amount of contaminants being released into the water, the contaminant loading can be lowered and the concentration can be maintained or lowered depending on the extent of both effects. Most of the pollution prevention and waste minimization options presented in this Guide belong to this latter category.

3.2 AREAS OF ENVIRONMENTAL CONCERN

Areas of environmental concern in fish processing plants include all locations where water comes into contact with fish, product, blood and/or offal. Such contact results in the solubilization or washing away of material which contributes to the concentration increase of contaminants such as TSS, BOD, and O&G. As the use of water sprays for certain purposes is a regulatory requirement for sanitation reasons, some of these areas may not be entirely eliminated. In such cases it is the extended contact of product or offal with water which represents a concern as it may result in increased contaminant concentrations. Other areas to be considered include the intimate mixing of water and offal, for example, during cleanup operations and pumping of small chunks of offal with wastewater.

It should be pointed out that vessel hold water which generally is discharged with the effluent from fish processing facilities, is a major contributor of contaminants to the combined effluent (R.Drew, 1994). Fish processing facilities have little or no control over the packer vessels, as these are generally independently owned. Further, herring and salmon are generally stored in water during their transport to the processing plants to maintain the quality of the fish (see

Section 2.3.1, 2.3.1). Therefore, it is not likely that alternative modes of transportation will be practiced in the near future.

Also of environmental concern is the excessive use of chlorine for disinfecting equipment and cannery cooling water. Chlorine is highly toxic to fish and other aquatic organisms. Proper use and handling should be clearly defined and outlined in the plant QMP and in employee training modules. Chlosrine levels should be discussed with representatives of the Fish Inspection Branch.

3.3 SOURCE REDUCTION AND PROCESS CHANGES

3.3.1 Product and/or Input Material Changes

Product and/or input material changes in an effort to achieve pollution prevention are not feasible for fish processing plants in the Lower Fraser River Basin as the particular products produced by the plants are the reason for their existence.

3.3.2 Process Technology and Equipment Changes

Good results have been achieved in the area of water conservation and contaminant load reduction with the installation of vacuum suction lines for offal removal in salmon dressing. Offal and/or blood removal by vacuum suction to eliminate any contact with water is believed to be one of the most promising areas of pollution prevention by process technology modification.

Herring sex sorters are available to separate male from female herring. The use of such sorters results in reduced water consumption and wastewater contaminant loadings, and reduces labour requirements for subsequent handling steps, as all male fish would be sent to a reduction plant rather than undergo additional handling (washing, freezing, cold storage, etc.). Ideally, sex sorting of herring should take place immediately after vessel unloading.

Sex sorters have high capital cost and are labour intensive, as they require manual placement and alignment of the fish. The economics of sex sorters would improve if they could be used in conjunction with automatic feeders which could also be used to supply automatic popping machines. Such feeders are presently in development.

Equipment design and construction also has an impact on the amount of waste generated and water consumed during cleanup. Ideally, equipment should be built with smooth surfaces and without sharp corners to minimize the amount of product and/or offal being caught on the equipment. Further, surfaces which come in contact with product or offal should be easily accessible to facilitate hand cleaning.

The thermodynamics of thawing procedures can also be significantly improved (economically) by injecting compressed air into thawing tanks. This prevents the water in the tanks from stratifying by temperature, it adds more heat to the system and it used less water.

3.3.3 Best Management Practices

3.3.3.1 General

Best management practices (BMPs) generally include relatively inexpensive modifications to processes or operating procedures designed to reduce or prevent the amount of pollution generated at a facility. Generally BMPs are applicable to a wide variety of fish processing plants regardless of the type of fish processed, applied technology or site specific conditions. BMPs include water conservation, waste stream separation, by-product recovery, clean-up, employee education and training, and some minimal wastewater treatment, generally in the form of screening.

3.3.3.2 Water Conservation

Although water conservation measures would at first glance seem not to affect the contaminant loading, experience at fish processing plants which have implemented extensive water saving measures indicates that substantial reductions in contaminant loadings are possible. For example, fish processors in northern Europe who have implemented extensive water conservation measures have found that, as a rule of thumb, a reduction of 50 % in water consumption results in a 40 - 45 % reduction in BOD loading leading to a small increase in BOD concentration of 10 - 20 % (NovaTec, 1993b). Water conservation also allows the use of smaller and therefore, less costly equipment for wastewater treatment.

Water conservation may be achieved through:

- dry transport of offal (from location of offal generation to intermediate storage);
- dry cleanup of equipment, offal and blood spills;
- dry transport of product;
- installation of shut-off nozzles on clean-up hoses;

- replacement of high-volume/low-pressure sprays with low-volume/high-pressure washers. High-pressure sprays should be used only after sufficient dry cleanup;
- installation of low-flow nozzles on equipment sprays;
- reduction of water pressure on equipment spray nozzles;
- shutting off all water flow during breaks, with the exception of water used for cleanup;
- implementation of water recycling, such as the reuse of retort cooling water for fluming of offal, if dry transport of offal is not possible;
- prompt repair of leaking equipment and pipes;
- use of in-place-cleaning systems when possible; and
- installation of flow control valves.

Water conservation practices should not compromise plant sanitation, and must be in agreement with regulatory requirements. Close attention should be paid to clean-up procedures. Typically a common clean-up program consists of hosing down floors and equipment with copious quantities of water. Hoses are often left unattended, and running on the floors. Clean-up, using a pail of warm, soapy water and a stiff brush, followed by a rinse with fresh water and a disinfectant drench, does a better job and produces less effluent than does the process of using high volume, high pressure hoses. Many plants also use vastly too much chlorine in their disinfection procedures, and too much water. Effluent quality can be improved and volumes reduced by keeping chlorine concentration as low as possible. For disinfection programs, use of 50 ppm chlorine and using only enough water to wet the equipment are good practices. These steps should be outlined in the company QMP and should be adhered to in practice.

Dry clean-up includes the following (in each case the offal should be directly transported to the offal hopper without any contact with water):

- cleaning of dressed fish using vacuum hoses connected to a cyclone separator followed by discharge of the collected blood and offal to the offal hopper rather than into the wastewater collection system;
- cleaning of floor spills with squeegees (into pans) to prevent them from entering drains;
- use of stiff brooms to clean floor prior to wash down;
- cleaning of equipment by hand or with stiff brushes prior to wash down.

Dry transport of offal generally refers to the use of conveyors in place of flumes or wet pumps. Such modifications are generally associated with substantial reductions in the contaminant loads.

Water recycling is a component of water conservation which should only be implemented if the quality and safety of the product will not be compromised. Recycled water should move from clean operations to less clean operations, however, water used for processing must be potable.

A major factor in implementing water conservation is employee education and training to change engrained but wasteful practices.

3.3.3.3 Waste Stream Separation

Waste stream separation in fish processing facilities has two main elements. The first involves the separation of offal and blood from water and wastewater in an effort to minimize the amount of contaminants dissolved by and suspended in the wastewater. The second element involves segregating high strength waste streams from those which are only slightly contaminated and/or meet applicable discharge criteria. In this second type of waste stream separation, the more contaminated stream may be treated separately, requiring lower capital costs, while the less contaminated stream may be recycled for applications not requiring sanitary conditions or may be discharged directly (after screening).

Separation of different process waste streams is strongly recommended. Together with water conservation, separation of process waste streams is a major factor in achieving a reduction in contaminant loadings. The major measures in waste stream separation include:

- dry transport of offal;
- immediate separation of offal and product from process water using dewatering belts;
- avoidance of bloodwater seepage from offal hoppers, or collection of this waste stream;
- installation of pans under tables to collect dripping blood and offal for subsequent discharge to the offal hopper;
- installation of trays under conveyor belts to catch solids before they fall on the floor;
- installation of chutes to direct offal to the offal handling system and to avoid the accumulation of offal on the floor;
- collection of offal in non-leaking containers;
- screening process wastewater prior to pumping;
- use of pumps designed to reduce break-up and, therefore, solubilization of solids (only useful if the previous option cannot be implemented);
- use of vacuum suction for gurry collection;
- use of sex sorters in roe herring processing; and
- use of finer mesh screens (down to 0.15 mm) to separate solids from the wastewater liquid stream.

The above measures can reduce the organic loading from a fish processing facility by approximately 50 to 60 %.

3.3.3.4 By-Product Recovery and Increased Processing Efficiency

By-product recovery is a cost effective way to reduce the amount of waste that would, otherwise, be disposed of. There are numerous by-product recovery options in the fish processing industry such as:

- fish meal;
- pet food;
- fertilizers;
- fish silage;
- protein hydrolysates;
- chitin and chitosan;
- food flavours;
- bone meal;
- bait;
- fish scales.

The predominant commercial use of fisheries waste in the Lower Fraser Basin is the production of fish meal.

Increased processing efficiency reduces the amount of offal generated and may result in additional revenues due to the utilization of more meat per fish. Equipment and processes to be considered under this category include fish head splitters that allow the removal of meat from cheeks and necks (PPRC, 1993), and mechanical deboning (mincing) (Goldhor, 1991).

3.3.3.5 Importance of Employee Education, Training, and Awareness

Most of the BMPs related to water conservation and waste stream separation are low-tech but require a certain willingness of workers and operators to implement changes and to strictly adhere to the new operating procedures. This may not be easy at first, as it requires the "unlearning" of established practices and becoming aware of the problems fish processing facilities are faced with. This can be a time consuming process which may have to be repeated throughout the processing seasons and/or at the beginning of each new season. However, as the implementation of these BMPs ultimately has to be accomplished by the workers in the processing area, this effort is not only necessary but will also lead to the desired results. Workers who are aware of the general approaches to water conservation and waste minimization are also able to recognize problem areas and to come up with solutions.

Chlorine injection systems for pretreatment or sterilization of processing water are often set far too high. After a sufficient period of contact time in the system, a slight residual of free chlorine in the water is all that is required to assure potability. Other systems to ensure potable water supplu may also be used, including ultra violet or ozonation sterilization systems. These have no toxic residuals. It should be noted that these forms of water treatment or sterilization are only to ensure potability of process water, and are not effective for plant sanitation procedures.

3.3.4 Waste Treatment, Recycling and Disposal

Waste treatment and disposal have already been addressed in Section 2.7. Recycling of solid waste from fish processing plants is generally carried out as described in Section 2.6.4.2. Recycling and/or reuse of liquid waste is generally only possible in few cases, such as reusing chilled water used for storing fish for the same purpose and the use of liquid waste for fluming offal. Fluming offal should be avoided and the recycling of liquid waste for this purpose should only be contemplated as an intermediate solution.

4 PROCEDURE FOR THE DEVELOPMENT OF POLLUTION PREVENTION PLANS

4.1 INTRODUCTION

Table 3 presents an overview of the steps involved in developing pollution prevention plans for fish processing plants. The following sections contain detailed instructions for carrying out each of the steps identified. Where applicable, the instructions are followed by worksheets which were designed to structure and facilitate the tasks for each step. Some of the worksheets pose close-ended questions to identify deficiencies which should be alleviated or which point to potential pollution prevention measures. As this is a general Guide, certain questions may not apply to individual plants. Any such questions should be answered with N/A (not applicable) and reasons for such an answer should be noted in the "Comment" column.

Generally, the steps and tasks are further divided into "Purpose", "Activities", and "Comments". Under "Purpose", the objectives of each particular step or task are itemized. The "Activities" section provides a list of the work which needs to be carried out, and the "Comment" section provides pointers for how it should be carried out and what additional factors should be taken into consideration.

Some of the worksheets require simple calculations. It may be more convenient and efficient to set up these worksheets as computer spreadsheets. This would also allow the combining of logically connected worksheets and the sorting of data.

The approach to develop pollution prevention plans presented in this section is detailed and highly structured and, therefore, should be considered a guideline only. Depending on the reason for developing such a plan, the familiarity of the personnel (carrying out the work) with the plant, regulatory requirements, and technical issues, the Guide may be streamlined to allow for faster response.

In all cases, the development of pollution prevention plans should be discussed with federal and provincial Inspection staff, to assure product safety and integrity and regulatory compliance. Appropriate amendments or changes should also be made to the plant QMP and should be approved by the regulatory authorities.

Table 3: Pollution Prevention Plan Development Overview

Step		Task Description/Purpose
1	Organize Program	Select team members to develop pollution prevention plans Develop pollution prevention goals Establish timeline for development of pollution prevention plan
2	Conduct Environmental Review	Compile plant data Identify and obtain missing information
3	Conduct Detailed Assessment	Inspect facility Identify potential pollution prevention and water conservation areas Determine existing waste generation and water consumption levels Identify pollution prevention options Conduct technical feasibility assessment Conduct environmental evaluation Conduct economic feasibility assessment Rank pollution prevention options Prepare and review the assessment report
4	Write Pollution Prevention Plans	Determine appropriate implementation schedule for pollution prevention options
5	Regulatory Review	Obtain review and approval from appropriate regulatory agencies for the implementation of pollution prevnetion options, eg. the amendment of the plant QMP.
6	Implement Pollution Prevention Plan	Implement pollution prevention options according to plan
7	Assess Progress	Evaluate pollution prevention progress Compare pre and post pollution prevention plan waste generation

4.2 STEP 1: ORGANIZE PROGRAM

4.2.1 Task 1.1: Select Team Members

Purpose
To select staff with sufficient technical, business, and communication skills to develop a facility-specific pollution prevention plan.

Activities
1. Select team members responsible for the development of the pollution prevention plan.
2. Appoint a team leader.
3. Determine responsibilities of team members.

Comments
In addition to substantial technical, business, and communication skills, the team members should have thorough knowledge of the company. The key areas of expertise to consider include:

- environmental;
- quality control;
- production and maintenance; and
- management.

Input from staff of the following areas may also be required:

- engineering;
- health and safety;
- legal; and
- accounting and purchasing.

The pollution prevention team (P2 Team) leader and members, their areas of expertise, and their responsibilities should be indicated in Worksheet No. 1. The first activities to be carried out by the P2 Team should include the development of pollution prevention goals and the establishment of a timeline to carry out all steps necessary to develop a facility-specific pollution prevention plan (see Task 1.2).

4.2.2 Task 1.2: Develop Pollution Prevention Goals.

Purpose

Identify the scope and objectives/goals of the pollution prevention plan.

Activities

1. Review historical discharge data to develop realistic goals.
2. Develop timeline for the development of pollution prevention plans (see Worksheet No 2).
3. Determine reporting structures to ensure that the timeline is adhered to.

Comments

The goals serve to focus effort and build consensus. Generally goals should be:

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

For fish processing plants the goals may include quantitative goals such as:

- Percent reductions in the concentrations and/or normalized[1] loadings of one or several contaminants discharged; or
- Percent reduction in the water consumption per units of production[2] or weight of fish processed.

Discharge permits and effluent monitoring results should be reviewed to determine if permit violations occur. If this is the case, the pollution prevention goals should include the goal of

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[1]Normalized contaminant loadings (see Section 3.1) are generally the preferred form of presenting pollution prevention goals, as normalization allows season to season comparison and comparison between different companies. Normalization of contaminant loadings is achieved by dividing contaminant loadings by the weight of fish processed or the units of production (see below) produced during the time for which the loading was determined. For example, a normalized BOD loading may be presented in units of kg BOD/t of dressed or round (raw) fish (kilogram of BOD discharged per tonne of dressed or raw fish), or kg BOD/t of herring roe (kilogram of BOD discharged per tonne of herring roe produced).

[2]Units of production includes: amount of fish processed, weight or number of pallets of cans produced, weight of herring roe produced.

meeting permit requirements. A review of the discharge permit may also indicate wastewater contaminants of concern. As a minimum, the list of contaminants which may be considered when developing pollution prevention goals should include the following:

- BOD;
- TSS; and
- O&G.

Chlorine may have to be added to this list for canneries discharging directly into the environment.

Due to the impact that fish species and processing type have on the wastewater contaminant concentrations and loadings, the pollution prevention goals may be adjusted according to the predominant type of fish processing taking place during clearly distinguishable operating seasons.

If insufficient data is available to the P2 Team to develop pollution prevention goals at this point of the program, it may be more practical to postpone the development of such goals until the data compilation phase of the next step has been carried out. The pollution prevention goals should be indicated in Worksheet No. 1.

The need for developing and adhering to realistic timelines is of particular importance for those fish processing facilities that are involved in seasonal processing, as the pollution prevention program may be delayed by one year if identified milestones cannot be met within one processing season.

Pollution Prevention Assessment Worksheets		
Worksheet No. 1		**Program Organization**
Prepared by:	Date:	
Process Type/Operation:		
Program Team		
Name	Title	Responsibility
Pollution Prevention Goals:		
Reporting Requirements:		

Pollution Prevention Assessment Worksheets

Worksheet No. 2 **Timeline**

Prepared by: Date:

Process Type/Operation:

	MONTH	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept	Oct.	Nov	Dec.
TASK	**Year**												
Compile plant data													
Identify and obtain missing information													
Inspect facility													
Identify pot. P2 and water cons. areas													
Det. ex. waste gen. and water cons. levels													
Identify pollution prevention options													
Conduct technical feasibility assessment													
Conduct environmental evaluation													
Conduct economic feasibility assessment													
Rank pollution prevention options													
Prepare and review the assessment report													
Det. appr. impl. schedule for P2 options													
Implement P2 options according to plan													
Evaluate pollution prevention progress													
Compare pre and post P2 plan waste gen.													

WORKSH2 WP6

4.3 STEP 2: CONDUCT ENVIRONMENTAL REVIEW

Purpose

Compilation of facility-specific background information necessary to develop pollution prevention plans and to evaluate their effectiveness.
Identification and subsequent acquiring of missing information.

Activities

1. Fill out Worksheets No. 3 and 4 to provide general facility information and to indicate if the information needed to complete subsequent worksheets is available and up-to-date.
2. Obtain or update missing or outdated information.

Comments

Worksheet No. 4 should be filled out for each distinct type of fish processing (such as roe herring and salmon processing). In order that the P2 Team can accurately evaluate pollution prevention options and their impact on their plant, accurate and complete data must be available to the team (to the extent practical). The information listed in Worksheet No. 4 is necessary to develop pollution prevention plans and to carry out economic feasibility assessments of P2 options.

Pollution Prevention Assessment Worksheets **Worksheet No. 3 General Facility Information**		
Prepared By:	Date:	
General Facility Information		
Parent Organization	Subject Facility	
Name:	Name:	
Address:	Address:	
City:	City:	
Province/Postal Code:	Province/Postal Code:	
Telephone:	Telephone:	
Fax:	Fax:	
Facility Production Information		
Major Operations:		
SIC Code(s): 1021 (Fish Products Industry)		
Production Level(s) (previous calendar year):		
Regulatory Information (check all that apply)		
☐	Liquid Waste (Effluent) Permit	Permit No.:
☐	Air Permit	Permit No.:
☐	Other (please list)	Permit No.:

Pollution Prevention Assessment Worksheets

Worksheet No. 4 **Process Information**

Prepared by: Date:

Document		Status		
		Complete and Current? (Y/N)	Document No.	Location
1	Process Flow Diagrams			
	Flow/Amount Measurements			
2	Water Usage			
3	Wastewater			
4	Product Stream(s)			
5	Offal Generation			
6	Analytical Data Wastewater Stream(s)			
	Revenue			
7	Product			
8	By-Product			
9	Offal			
10	Operating Season			
11	Waste Management Cost			
12	Water Cost			
13	Process Description			
14	Operating Manuals			
15	Equipment List/ Specification			
16	Piping/Instrument Diagrams			
17	Site/Building/Elevation Plan(s)			
18	Environmental Audit Reports			
19	Others			
20				
21				
22				
23				
24	Type of Vessel Hold Water Disposal			

4.4 STEP 3: CARRY OUT DETAILED ASSESSMENT

4.4.1 Task 3.1: Inspect Facility

Purpose

To review the entire fish processing operation in order to identify all areas of waste generation and water use.

Activities

1. Use Worksheets No. 5 and 6 to inspect equipment and/or processes, and the entire plant, respectively.
2. Use a separate copy of Worksheet No. 5 for each piece of equipment (such as a conveyor or iron butcher) or process (such as salmon dressing or pick-up of offal for transport to reduction plant).
3. Follow the process including all side and waste streams from the beginning to end while observing operating procedures in order to complete Worksheets No. 5 and 6 and verify and/or correct flow diagram(s).

Comments

This task provides the background information for the development of pollution prevention plans. Therefore, it is important to ensure that observed operating conditions are typical. Operators or supervisors may have to be interviewed to determine if this is the case and to identify how deviations from typical operating conditions would affect the review. All operations, including startup and cleanup, and conditions during breaks and shift changes should be observed.

Pollution Prevention Assessment Worksheets **Worksheet No. 5 (Page of) Waste Stream Separation**				
Prepared By:				Date:
Process Type:				
Equipment/Process:				
	Ensure the following is indicated on flow diagram:			Comment
1	▸ All water addition points.			
2	▸ All water discharge points.			
3	▸ All offal and blood discharge points.			
4	▸ Method of waste handling (conveyor, flume, etc.)			
5	▸ All locations where water contacts product, offal, or blood.			
	Note: A "Yes" answer to the following questions indicates a potential pollution prevention area.	Yes	No	*See Section 3.3.3.3 for potential improvements.*
6	Does offal/blood accumulate on equipment?			
7	Does offal/blood accumulate on floor below equipment?			
8	Is offal/blood in contact with water?			
9	Are water sprays used to flush offal/blood from equipment?			
10	Do valves have to be installed to control individual sprays?			
11	Would installation of low-flow nozzles reduce water consumption?			
12	Can water sprays use less pressure?			
13	Can offal be removed from water sooner?			
14	Can additional "dry" equipment cleaning methods be implemented?			
15	Is product sprayed with water?			
16	Is equipment adjusted incorrectly?			
17	Others			

Pollution Prevention Assessment Worksheets **Worksheet No. 6 Water Conservation**			
Prepared By:			Date:
Process Type:			
Equipment/Process:			
	Yes	No	Comment/Location
Are all water hoses equipped with low-flow shut off nozzles?			
Are equipment sprays turned off when equipment not in use (e.g breaks, equipment cleaning)?			
Are water sprays adjusted or turned off individually?			
Are floors and equipment cleaned by "dry" methods prior to hose downs?			
Are equipment sprays adjusted according to amount and/or type of processing?			
Are leaking taps repaired immediately?			
Are gratings of floor drains kept in place?			
Are workers careful not to drop offal or product on floors?			
Herring Processing:			
Are sexeors used for roe herring processing?			
Is curing brine being recycled?			
Other:			

Note: A "No" answer indicates a potential pollution prevention area. See Section 3.3.3.2 for potential improvements.

4.4.2 Task 3.2: Identify Potential Pollution Prevention and Water Conservation Areas

Purpose

Identification of the areas with the greatest potential for pollution prevention and/or water conservation.

Activities

Use the updated flow diagrams, any available flow measurements and analytical data (see Worksheet No.4), and filled out copies of Worksheets No. 5 and 6 to determine major areas of water consumption and/or areas of high strength wastewater generation.

Comments

Areas of high water consumption are generally easily recognized even if accurate flow measurements are not available. In addition to water consumption related to actual processing, water consumption during clean-up operations should also be considered.

Generally, high strength wastewater is generated where water is in contact with relatively large quantities of blood or offal. These include equipment sprays from iron butchers, gutting machines, and canning machines, and offal fluming. Other potential pollution prevention areas include those where water is allowed to come in contact with easily segregated wastestreams such as:

- bloodwater seepage from offal hoppers;
- gurry from canning machines; and
- offal removed by vacuum suction.

Generally, the more blood is mixed with process water and the longer offal is in contact with the water, the higher the wastewater strength.

4.4.3 Task 3.3: Determine Existing Waste Generation and Water Consumption Levels

Purpose
To provide the input data required for evaluating the environmental and economical benefit of pollution prevention options.

Activities (see Worksheet No. 7)

1. Review available data (see Worksheet No. 4) to determine if water consumption measurements and analytical data for each of the wastestreams identified in Task 3.2 are available.
2. Obtain any missing data.
3. In Worksheet No. 7, enter the data for the parameters BOD, TSS, and O&G (use a separate worksheet for each contaminant).
4. Calculate the contaminant loading by multiplying the contaminant concentration by the wastewater flow (Column 3 times Column 2) and enter the result in Column 4.
5. Calculate the contaminant loading per weight of round fish processed by dividing the contaminant loading by the weight of fish processed (Column 4 divided by Column 5) and enter the result in Column 6.
6. In Column 7 calculate for each wastewater stream the water consumption per weight of fish processed by dividing the flow of water used (Column 2) by the weight of round fish processed (Column 5).
7. Any applicable comments may be included in Column 8 or on an attached sheet.

Comments
The data required for each identified wastestream should include all parameters for which the discharge permit identifies a limit. The parameters listed above should be considered a minimum requirement.

The" wastewater flow" and "weight of round fish processed" can be reported hourly or daily. The same period must be used for both parameters.

Consistent units should be used throughout the calculations to ensure that conversions are carried out correctly. Other normalization factors (see Task 1.2) may be substituted for "weight of round fish processed".

Descriptions of methods to collect the necessary data are contained in *How to Do a Seafood Processing Plant Water, Waste, and Wastewater Audit* published by the B.C. Ministry of Agriculture, Fisheries and Food. The approximate contribution of each of the identified potential pollution prevention areas to the final wastewater contaminant loading and wastewater flow should be estimated. This requires that sampling of the individual wastewater streams and the final effluent be conducted at the same time. The combined effluent should be sampled prior to any screening. Determining the contribution of each wastestream to the total contaminant loading shows how much of the contaminant may be removed if a particular source is eliminated. It also confirms whether all large wastewater contributors have been accounted for.

It should be pointed out, that due to the variability in fish processing, combined with inherent inaccuracies in the sampling, flow measurement, and analytical process, the contaminant loading of the combined, unscreened wastewater may not be accounted for completely.

Pollution Prevention Assessment Worksheets

Worksheet No. 7 (Page of) **Data Compilation**

Prepared by: Date:

Process Type/Operation:

Contaminant: BOD, TSS, O&G, Other (circle one, if other, please indicate):

1	2	3	4	5	6	7	8
Wastestream	Before Implementation of Pollution Prevention Option					Water Consumption per Weight of Round Fish Processed	Comment
	Flow	Contaminant					
		Conc.	Loading	Weight of Round Fish Processed	Loading per Weight of Round Fish Processed		
Unit	m^3/hr	mg/L	kg/hr	t/hr	kg/t	m^3/t	
Example			$\frac{(2) \times (3)}{1000}$		$\frac{(4)}{(5)}$	$\frac{(2)}{(5)}$	

4.4.4 Task 3.4: Identify Pollution Prevention Options

Purpose
To provide a selection of options to meet the targeted pollution prevention goals for all potential pollution prevention areas.

Activities (see Worksheet No. 8)

1. Review the general pollution prevention principles and specific pollution prevention options presented in Section 3.3.3 and/or additional literature to identify those options which would provide a workable solution to the pollution prevention problem at hand.
2. In Worksheet No. 8 list for each wastestream all options identified (use separate rows for each option).

Comments
Wastestreams may have several potential pollution prevention options which should all be included in Worksheet No. 8. This task is a brainstorming activity involving all P2 Team members. Pollution prevention options should be identified and listed in Worksheet No. 8 disregarding their technical or economical feasibility. A selection of the most appropriate option for each pollution prevention area and the order of option implementation if several options are required will be carried out in Task 3.9.

Possible pollution prevention options may also include changes to operating procedures (for example changing from wet to dry cleanup procedures), which generally require at least some form of employee training.

In addition to pollution prevention options, it may be appropriate to re-assess existing by-product re-use practices (see Section 3.3.3.4). This is not expected to appreciably reduce the contaminant loading of fish processing plant effluents since virtually all by-products are currently re-used, but it may increase the revenues of a processing facility.

Pollution Prevention Assessment Worksheets

Worksheet No. 8 (Page of) **Environmental Evaluation**

Prepared by: Date:

Process Type/Operation:

Contaminant: BOD, TSS, O&G, Other (circle one, if other, please indicate):

1	2	3	4	5	6	7	8	9	10
Wastestream	Pollution Prevention Option	Tech. Feas. (yes/ no/ Pilot)	Conditions Before Implementation of Option		% Reduction After Implementation of Pollution Prevention Option		Average Weight of Round Fish Processed During Season	Reduction in Total Loading During Season	Water Reduction During Season
			Loading per Weight of Round Fish (see Column 6, Worksheet 7)	Water Consumption per Weight of Round Fish (see Column 7, Worksheet 7)	Water Use	Loading			
Unit			kg/t	m^3/t	%	%	t	kg	m^3
Example								$\frac{(7)x(4)x(8)}{100}$	$\frac{(6)x(5)x(8)}{100}$

4.4.5 Task 3.5: Conduct Technical Feasibility Assessments

Purpose
To evaluate if pollution prevention options are technically feasible.

Activities (see Worksheet No. 8)
1. Evaluate the technical feasibility of each option and indicate in Column 3 if an option is feasible or if pilot tests are required to determine the feasibility of an option.
2. If it is not clear if a pollution prevention option is technically feasible, information to determine its feasibility should be obtained. The following sources may be consulted:

- qualified in-house staff;
- equipment manufacturers/suppliers; and
- outside consultants.

Comments
If the technical feasibility evaluation indicates that pilot-scale studies should be carried out, this should be taken into consideration for the economic feasibility analysis and the implementation plan (see Step 4).

4.4.6 Task 3.6: Conduct Environmental Evaluation

Purpose
To determine the environmental benefits of each option identified.

Activities (see Worksheet No. 8)
1. In Worksheet No. 8, list for each technically feasible option the estimated percent reduction in the wastewater volume and contaminant loading if the option is implemented (Worksheet No. 8 should be completed for each contaminant for which discharge fees are to be paid i.e. BOD, TSS, O&G, etc.).
2. In Column 4 enter the "contaminant loading per weight of round fish processed" (copied from Column 6, Worksheet No. 7)
3. In Column 9 calculate the total contaminant loading reduction for each option by multiplying the loading reduction by the contaminant loading per round fish (before implementation of the option) and the average weight of round fish processed per season (Column 7 times Column 4 times Column 8, divided by 100). This difference represents the potential environmental benefit which may be realized if the particular option is implemented.
4. In Column 5 enter the "water consumption per weight of round fish processed" (copied from Column 7, Worksheet 7)
5. In Column 10 calculate the expected water savings during the processing season by multiplying the reduction in water consumption by the water consumption per weight of round fish (before implementation of the option) and the average amount of round fish processed per season (Column 6 times Column 5 times Column 8, divided by 100).

Comments
Care must be taken when estimating the percent reduction in the contaminant loading after implementation of an option, as certain options may primarily affect the water consumption which would not affect the loading. A reduction of 100% is equivalent to the complete elimination of a particular wastestream, for example when redirecting the discharge of vacuumed offal from a flume to an offal hopper.

The outlined calculations assume that the reductions in the contaminant loading and contaminant loading per weight of round fish processed are the same. This is generally the case unless the implementation of an option also affects the throughput. The reduction in the total contaminant loading (Column 9) should be multiplied (divided) by the decrease (increase) in the throughput. For example, if the implementation of an option results in a doubling of the throughput, the reduction in the total contaminant loading (Column 9) should be divided by 2.

If a process or equipment is to be replaced entirely by a new process or equipment, data regarding water consumption and contaminant loading per weight of round fish processed should be obtained from the manufacturer or supplier. This data should be subtracted from the pre-implementation water consumption and contaminant loading data to determine the applicable entries for Columns 6, 7, and 9.

Help from any of the sources listed in Task 3.5 may be required for assigning environmental benefits. It has to be recognized that it may be impossible to develop good estimates for all wastestreams.

4.4.7 Task 3.7: Conduct Economic Feasibility Evaluation

Purpose
To evaluate the total economic impact of each identified pollution prevention option.

Activities (see Worksheet No. 9)
1. In Columns 1 and 2, respectively, enter all wastewater streams and pollution prevention options identified for a particular stream.
2. In Column 3 enter for each option the reduction of the loading which could be realized by implementing that option (i.e. copy Column 9, Worksheet No. 8).
3. Indicate in Column 4 if a particular option is required by regulations and/or permits, or if the implementation of one or several options would result in meeting regulatory and/or permit requirements which would otherwise not be met.
4. Determine the net present value (NPV) of each pollution prevention option at the end of its life time and enter the result in Column 5.

Comments
Generally, the reduction in contaminant loading may be expressed in terms of any of the wastewater quality parameters of concern (BOD, TSS, O&G, etc.), as the reduction in the loading of these parameters as a result of implementing an option is expected to be similar.

NPV is defined as "the difference between the dicounted, or present, value of the future income and the amount of the initial investment" (Brealey, R. et al., 1992). The NPV is calculated over the life time of each pollution prevention option and indicates if the implementation of the particular option will result in net financial savings or losses, based on the assumptions used in the financial analysis. Savings are indicated by a positive, losses by a negative NPV. Many spreadsheet computer programs include functions to calculate the NPV.

For an accurate determination of the NPV of pollution prevention options, a total cost analysis must be carried out for each option. Such an analysis evaluates the impact of an option not only on direct costs such as capital, operating, and maintenance costs, but also on indirect costs, liability costs, and less-tangible benefits. Indirect costs include administration costs and all those costs which are accrued as a result of storage, handling, disposal, permitting, etc. associated with a particular product or process, but which are included in the general overhead costs. Liability costs are related to fines or penalties. Less-tangible benefits are sometimes difficult to estimate, as they are related to increased sales due to enhanced company image, etc. (see Appendix A). In order to carry out a total cost analysis, the above mentioned costs and benefits must be allocated in a fair manner on the processes affected by a particular pollution prevention option. The data compiled during completion of Worksheet No. 4 should be reviewed when carrying out such analyses. Any of the sources listed under Task 3.5 may have to be consulted to carry out this activity.

Other financial indicators such as "internal rate of return" and "profitability index" are sometimes used to evaluate proposed projects. These indicators should not be used when developing a pollution prevention plan, as they do not allow comparison of the net financial benefits among several options. Such comparisons are required to permit the ranking of options.

Pollution Prevention Assessment Worksheets

Worksheet No. 9 (Page of) **Ranking of Options**

Prepared by: Date:

Process Type/Operation:

1	2		3	4	5	6	7
Waste Stream	Pollution Prevention Option No.		Potential Loading Reduction kg	Permit Requirement ?	Net Present Value $	Rank	Comments

4.4.8 Task 3.8: Rank Pollution Prevention Options

Purpose

To determine the order in which pollution prevention options should be implemented based on environmental and economic considerations.

Activities

1. Plot each option using the net present value as the x-axis and the total annual loading reduction (see Column 3, Worksheet 9) as the y-axis.
2. Circle all points representing options which are required by regulations and or permits or whose implementation would result in meeting regulations and/or permits.
3. The following guidelines for ranking pollution prevention options for implementation should be observed:

- Pollution prevention measures required by regulations or permits (circled options) have highest priority.
- Rank remaining options according to decreasing environmental benefits and decreasing net present values (i.e. the options located in the upper right hand corner of the plot should be considered for implementation before the options located in the lower left hand corner).

4. Indicate the determined ranks in Column 6, Worksheet No. 9.

Comments

Ranking of options requires careful consideration by the P2 Team. For example, although the options in the upper left hand corner of the options plot have greater environmental benefits than those of the lower right hand corner, the former do not have as good a return of investment as the latter and may, therefore, cause a company to require more time for implementation of options. Conversely, the options in the lower right hand corner provide a higher economic benefit than those in the upper left hand corner and may enable a company to implement options sooner.

4.4.9 Task 3.9: Prepare Assessment Report

Purpose

To summarize the findings of the program thus far for review and approval by plant management.

Activities

1. Summarize and append worksheets.
2. Recommend order in which pollution prevention options should be implemented.
3. Indicate the following for each proposed pollution prevention option:

- actual and normalized pollution prevention potential;
- availability and reliability of technology;
- the overall project economics;
- advantages and disadvantages;
- implementation cost;
- payback period, including any assumptions made;
- estimated time for implementation ; and
- proposed method to measure performance after implementation.

Comments

The assessment report should contain all necessary information for management to develop an implementation plan (see Step 4). The recommendation with respect to order of option implementation should be based on the outcome of Task 3.8 .

4.5 STEP 4: WRITE POLLUTION PREVENTION PLAN

Purpose
To provide a written plan available to all staff.
To provide management with a planning document.
To provide for long-term environmental improvement planning.

Activities
1. Develop plan for implementing pollution prevention options based on the following:

- assessment report;
- company policy;
- expansion and/or modification plans; and
- cash flow projections.

2. The plan should clearly identify the following:

- the pollution prevention options selected;
- an option implementation schedule;
- personnel responsible for implementation of the plan;
- monitoring and reassessment procedures;
- deadlines for submission of internal, seasonal and/or annual progress reports.

3. Complete and append Worksheet No. 10, 11 to the pollution prevention plan.

Comment
In order to underscore the importance of a pollution prevention plan and to commit management, a preamble to the plan should be prepared. This preamble should include a management policy statement expressing support for the plan and a commitment to implement planned activities and achieve established goals. In addition, the preamble should identify the scope and objectives of the plan and should be signed by the owner, president, or chief executive officer.

Fish processing companies having clearly distinguishable processing seasons may wish to complete seasonal progress assessment reports as soon as practical after each season. This will allow sufficient time for evaluation of the progress made and for making modifications to the pollution prevention plan prior to the next similar processing season.

Pollution prevention options should be implemented in a logical order and in such a manner that they do not negatively impact on each other or on future improvements.

Pollution Prevention Assessment Worksheets

Worksheet No. 10 (Page of) **Option Implementation**

Prepared by: Date:

Process Type/Operation:

Pollution Prevention Options		Estimated Implementation Date (month/year)					
		Year 1	Year 2	Year 3	Year 4	Year 5	Later
No.							

4.6 STEP 5: REGULATORY REVIEW

Fish processors registered under the federal *Fish Inspection Act* and *Regulations* are required to develop and operate a Quality Management Program (QMP) for their plant operations. The QMP must be approved by the Department of Fisheries and Oceans, and includes process and procedures for plant clean-up and sanitation, and product handling. Changes to these procedures must also be reflected in the QMP and the revised QMP must be approved by the Fish Inspection Branch of the Department of Fisheries and Oceans. Processors are advised to consult with their Fish Inspection Branch representative in the development of the pollution prevention plan to assure that proposed changes to in-plant operations do not conflict with regulatory requirements. The revised QMP is required to be submitted to the Fish Inspection Branch for approval.

4.7 STEP 6: IMPLEMENT POLLUTION PREVENTION PLAN

The pollution prevention options should be implemented according to the developed plan. It should be pointed out that the implementation of modified operating procedures which are expected to contribute substantially to most pollution prevention efforts generally requires significant commitment on the part of management to train and motivate workers and operators. Generally, workers have become accustomed to environmentally unsound operating procedures and require on-going supervision and retraining until they have become accustomed to the new procedures.

Continuing emphasis by plant management that all pollution prevention measures, including good operating procedures, are of the utmost importance and that relapses to the "old ways" will not be tolerated, will go a long way in motivating workers. In addition, designating a Pollution Prevention Champion who can identify and stop environmentally unsound operating procedures and remind workers and their supervisors of the importance of good operating methods will facilitate the change in procedures. This is particularly true during the height of the processing season when the temptation to forsake good operating procedures for increased throughput is highest.

4.8 STEP 7: ASSESS PROGRESS

Purpose

To identify the effectiveness of pollution prevention measures.

To review and fine tune the implementation plan.

To evaluate if pollution prevention goals are being met.

Activities

1. Compile information required for Step 2 for the processing season following the implementation of some or all of the options identified in the pollution prevention plan.
2. Calculate loading and water consumption per weight of fish processed data as outlined in Worksheet No. 7 for the each targeted wastewater stream and the combined effluent. Enter data in applicable columns in Worksheet No. 11 (use a new copy of the worksheet for each wastewater stream).
3. Compare pre and post-implementation concentration, loading and water consumption data.
4. Carry out a post-implementation total cost analysis and compare its result to a pre-implementation analysis.
5. Review pollution prevention plan to determine if it should be modified.

Comments

Worksheet No. 11 should be completed for the final effluent and, if possible, for each major liquid waste stream identified in Step 2. Care must be taken that only periods of similar processing conditions are compared to each other (i.e. salmon canning should not be compared to roe herring processing). Any problems encountered during implementation of an option should be identified.

Criteria for the assessment of pollution prevention measures include contaminant concentration and loading of the wastewater discharged from a particular facility. To allow for seasonal comparisons and for comparisons between fish processing plants involved in similar processing, contaminant loadings should be normalized to the weight of round fish processed, or other suitable economic levels such as tonnes of roe produced, or number of pallets of cans produced.

Pollution Prevention Assessment Worksheets

Worksheet No. 11 (Page of)									**Program Assessment**
Prepared by:							Date:		
Process Type/Operation:									
Wastewater Stream:									
After Implementation of (list options):									
Total Net Present Value of all Options Affecting this Wastewater Stream:									
Parameter	Concentration				Loading				Water Use
					per weight of round fish processed				
	BOD	TSS	O&G	Other (Specify)	BOD	TSS	O&G	Other (Specify)	
Unit	mg/L	mg/L	mg/L	mg/L	kg/t	kg/t	kg/t	kg/t	m^3/t
Before									
After									
Improvement									

Normalization Factor:

(if different from "weight of round fish processed")

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Appendix A

Total Cost Analysis - Summary

The following is an excerpt from *Reference Workbook: Pollution Prevention Plan* (PCA, 1994) to illustrate the concept of total cost analysis:

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

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

To ensure complete accounting of all environmental related expenses and intangible costs and benefits, pollution prevention options should be evaluated using the Total Cost Assessment accounting method developed by USEPA (USEPA, 1992). This assessment method modifies the standard accounting system to improve the competitiveness of prevention-oriented investments.

There are four elements of Total Cost Assessment:

- Expanded cost inventory;
- Extended time horizon;
- Use of long-term financial indicators; and
- Direct allocation of costs to processes and products.

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

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

Appendix B

Economic Evaluation - Case Study

CASE STUDY - REPLACEMENT OF EQUIPMENT SPRAYS WITH VACUUM SUCTION FOR THE REMOVAL OF GURRY FROM CANNING MACHINES

This case study is for a hypothetical salmon cannery and is presented for demonstration purposes only. The assumptions used for the total cost assessment of the pollution prevention option presented here are based on unpublished data previously collected by NovaTec Consultants. All assumptions are listed in Tables 1 and 2. A spreadsheet program was used to carry out the calculations.

Gurry is the ground fish which accumulates on can filling machines during salmon canning. At Plant A it is normally flushed away by stationary water sprays and intermittent manual hose downs. The resulting wastewater exhibits high concentrations of BOD, TSS, and O&G.

The pollution prevention option recommended for this wastestream consists of removing the gurry by vacuum suction for subsequent discharge directly into an offal hopper.

The estimated reduction in contaminant loading from this operation is 80% and the water reduction is 40%. Water would still be required for the fish cutting operation, but the major contributor to the contaminant loading, the flushing away of gurry, would be eliminated. Capital and installation costs were estimated at $10,000.

The case study assumes that discharge fees are to be paid for the actual amount of contaminants discharged. The following two discharge scenarios were considered:

- discharge to the Fraser River; and
- discharge to the Greater Vancouver Sewerage and Drainage District (GVS&DD).

The discharge fee rates used for the calculations are identified in the appropriate tables and are based on B.C. Regulation 299/92, the Waste Management Permit Fee Regulation (discharge to the Fraser River) and a memo from the Sewerage and Drainage Committee to the Administration Board of the GVS&DD dated June 11, 1992 (discharge to the GVS&DD). The former does not include a fee for the volume of wastewater discharged, whereas the GVS&DD does not charge for O&G discharges.

In the case of the plant discharging to the Fraser River, it was assumed that the implementation of the pollution prevention option would prevent one fine over a ten year period which otherwise would have occurred. For purposes of the economic evaluation it was assumed that the fine would have occurred during the third year.

The background data for the economic evaluation are presented in Tables B-1 and B-2. No attempt was made to estimate less-tangible benefits such as improved relationship with regulatory agencies. Results of the evaluation are presented in Tables B-3 and B-4 (for discharge to the GVS&DD), and Tables B-5 and B-6 (for discharge to the Fraser River).

Discharge fees have a substantial impact on the net present values of the pollution prevention option, resulting in the net present value of the option to be positive ($10,056) for discharge to the GVS&DD, and negative (-$413) for discharge to the Fraser River. Therefore, implementation of the option would result in net savings only for a plant discharging to the GVS&DD.

TABLE B-1: CASE STUDY - ECONOMIC DATA

DIRECT COSTS	AMOUNT	COMMENT
CAPITAL EXPENDITURES		
Buildings	N/A	New building not required.
Equipment	$5,000	
Materials	$1,000	
Construction	$3,000	
Installation	$1,000	
Utility Connections	N/A	Utility connections are included in the installation costs.
Project Engineering	N/A	Not required because of the limited scope of the project.
Contingency	N/A	Not required because of the limited scope of the project.
Startup	N/A	Not required because of the limited scope of the project.
OPERATION AND MAINTENANCE EXPENSES OR REVENUES		
Raw Materials	N/A	No additional raw material (fish) required.
Maintenance Costs (% of Capital Costs)		
- Labour	2%	
- Materials	1%	
Discharge Fees		see Table B-2
Water and Energy		see Table B-2
Value of Recovered Material	N/A	No change, as large particles would be removed by the on-site micro screen.
INDIRECT COSTS		
Administrative Costs (% of Labour Costs)	10%	
Operating Supplies (% of Labour Costs)	5%	
Regulatory Compliance Costs	N/A	Sampling, analytical, and reporting costs are not expected to change.
Insurance	N/A	No change in insurance cost due to option.
Worker's Compensation	N/A	No change in insurance cost due to option.
On-Site Waste Management	N/A	Waste Management is not affected by the option.
On-Site Poll. Contr. Equip. Operat. ($/m3)	0.2	Operating and maintenance costs for on-site micro screen.
LIABILITY COSTS		
Fines	$200	Assumes one fine (during the third year of the project) that could have been prevented. Only applicable for discharge t Fraser River.
Additional Costs Related to Fines	$2,500	Includes additional sampling and analytical costs, and time of senior staff for reporting to regulatory agency.
FINANCING CONSIDERATIONS		
% Equity	100%	No loan is required for implementation of the option.
Escalation Rates	5%	Anticipated cost increases.
Depreciation Period (year)	10	
Capital Cost Allowance	20%	
Income Tax Rate	25%	
Expected Project Life (year)	10	
Salvage Value after 10 Years	$0	
Cost of Capital	12%	

TABLE B-2: CASE STUDY - DISCHARGE, WATER, ENERGY, AND LABOUR COSTS PER SEASON BEFORE AND AFTER OPTION IMPLEMENTATION

		DISCHARGE TO					
		GVS&DD			FRASER RIVER		
PARAMETER	UNIT	BEFORE	AFTER	DIFF.	BEFORE	AFTER	DIFF.
BOD							
Discharge Rate	kg/t	4.6	0.92	3.68	4.6	0.92	3.68
Fee Rate	$/kg	$0.13	$0.13	$0.00	$0.0139	$0.0139	$0.00
Total Fee	$	$897	$179	$718	$96	$19	$77
TSS							
Discharge Rate	kg/t	5.3	1.06	4.24	5.3	1.06	4.24
Fee Rate	$/kg	$0.27	$0.27	$0.00	$0.01	$0.01	$0.00
Total Fee	$	$2,147	$429	$1,717	$73	$15	$59
O&G							
Discharge Rate	kg/t	1	0.2	0.8	1	0.2	0.8
Fee Rate	$/kg	$0.00	$0.00	$0.00	$0.05	$0.05	$0.00
Total Fee	$	$0	$0	$0	$69	$14	$55
Wastewater Volume							
Discharge Rate	m3/t	1.3	0.78	0.52	1.3	0.78	0.52
Fee Rate	$/m3	$0.12	$0.12	$0.00	$0.00	$0.00	$0.00
Total Fee	$	$234	$140	$94	$0	$0	$0
Water Consumption							
Usage Rate	m3/t	1.3	0.78	0.52	1.3	1	1
Unit Cost	$/m3	$0.25	$0.25	$0.00	$0.25	$0.25	$0.00
Total Cost	$	$488	$293	$195	$488	$293	$195
Energy Consumption							
- Pumping of Wastewater							
Usage Rate	kWh/t	0.118	0.071	0.047	0.118	0.071	0.047
Unit Cost	$/kWh	$0.07	$0.07	$0.00	$0.07	$0.07	$0.00
Total Cost	$	$12	$7	$5	$12	$7	$5
- Motor of Vacuum Suction							
Usage Rate	kWh/t	0	0.559	(0.559)	0	0.559	(0.559)
Unit Cost	$/kWh	$0.07	$0.07	$0.00	$0.07	$0.07	$0.00
Total Cost	$	$0	$59	($59)	$0	$59	($59)
Labour							
Usage Rate	hr/shift	0.5	0.06	0.44	0.50	0.06	0.44
Wage Rate	$/hr	$20	$20	$0	$20	$20	$0
Total Cost	$	$950	$114	$836	$950	$114	$836

Notes:

1 The BOD, TSS, and O&G loading will be reduced by: 80%
2 Water use and wastewater discharge will be reduced by: 40%
3 Number of shifts/operating period 95
4 Shift duration (hr): 12
5 Weight of fish processed per operating season (t): 1,500
6 The reduction in wastewater discharge also results in reduced pumping requirements.
7 The reduction in labour is due to reduced equipment hose down requirements.
8 To differentiate costs from savings, costs are shown in brackets.

TABLE B-3: SAVINGS/(COST) SUMMARY DURING LIFETIME OF PROJECT - DISCHARGE TO GVS&DD

Operating Year	1	2	3	4	5	6	7	8	9	10
Escalation Factor	1	1.050	1.103	1.158	1.216	1.276	1.340	1.407	1.477	1.551
SAVINGS/(COSTS)										
Discharge Fees	$2,528	$2,655	$2,788	$2,927	$3,073	$3,227	$3,388	$3,558	$3,736	$3,922
Water Fees	$195	$205	$215	$226	$237	$249	$261	$274	$288	$303
Energy Fees	($54)	($56)	($59)	($62)	($65)	($69)	($72)	($76)	($79)	($83)
On-Site Poll. Cont. Equip. Operat.	$156	$164	$172	$181	$190	$199	$209	$220	$230	$242
Maintenance Labour	($120)	($126)	($132)	($139)	($146)	($153)	($161)	($169)	($177)	($186)
Maintenance Supplies	($60)	($63)	($66)	($69)	($73)	($77)	($80)	($84)	($89)	($93)
Operating Labour	$836	$878	$922	$968	$1,016	$1,067	$1,120	$1,176	$1,235	$1,297
Operating Supplies	$42	$44	$46	$48	$51	$53	$56	$59	$62	$65
Administrative Fees	$96	$100	$105	$111	$116	$122	$128	$135	$141	$148
Total Expenses Related to Fines	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL OPERATING SAVINGS/(COSTS)	$3,619	$3,800	$3,990	$4,190	$4,399	$4,619	$4,850	$5,092	$5,347	$5,614

Note: Costs are shown in brackets.

TABLE B-4: NET PRESENT VALUE OF PROJECT DURING ITS LIFETIME - DISCHARGE TO GVS&DD

Operating Year	0	1	2	3	4	5	6	7	8	9	10
Book Value	$10,000										
Undepreciated Capital Cost		$10,000	$8,000	$6,400	$5,120	$4,096	$3,277	$2,621	$2,097	$1,678	$1,342
Capital Cost Allowance		$2,000	$1,600	$1,280	$1,024	$819	$655	$524	$419	$336	$268
TAXABLE INCOME											
Operating Savings		$3,619	$3,800	$3,990	$4,190	$4,399	$4,619	$4,850	$5,092	$5,347	$5,614
Capital Cost Allowance		-$2,000	-$1,600	-$1,280	-$1,024	-$819	-$655	-$524	-$419	-$336	-$268
Terminal Loss											-$1,342
Taxable Income		**$1,619**	**$2,200**	**$2,710**	**$3,166**	**$3,580**	**$3,964**	**$4,326**	**$4,673**	**$5,012**	**$4,004**
PROFIT AFTER TAX											
Taxable Income		$1,619	$2,200	$2,710	$3,166	$3,580	$3,964	$4,326	$4,673	$5,012	$4,004
Income Tax		-$405	-$550	-$678	-$791	-$895	-$991	-$1,081	-$1,168	-$1,253	-$1,001
Profit after Tax		**$1,214**	**$1,650**	**$2,033**	**$2,374**	**$2,685**	**$2,973**	**$3,244**	**$3,505**	**$3,759**	**$3,003**
AFTER TAX CASH FLOW											
Profit after Tax		$1,214	$1,650	$2,033	$2,374	$2,685	$2,973	$3,244	$3,505	$3,759	$3,003
Capital Cost Allowance		$2,000	$1,600	$1,280	$1,024	$819	$655	$524	$419	$336	$268
Terminal Loss											$1,342
After Tax Cash Flow	**-$10,000**	**$3,214**	**$3,250**	**$3,313**	**$3,398**	**$3,504**	**$3,628**	**$3,769**	**$3,924**	**$4,094**	**$4,613**
NET PRESENT VALUE		**-$7,130**	**-$4,539**	**-$2,181**	**-$22**	**$1,967**	**$3,805**	**$5,509**	**$7,094**	**$8,571**	**$10,056**

TABLE B-5: SAVINGS/(COST) SUMMARY DURING LIFETIME OF PROJECT - DISCHARGE TO FRASER RIVER

Operating Year	1	2	3	4	5	6	7	8	9	10
Escalation Factor	1	1.050	1.103	1.158	1.216	1.276	1.340	1.407	1.477	1.551
SAVINGS/(COSTS)										
Discharge Fees	$191	$200	$210	$221	$232	$243	$256	$268	$282	$296
Water Fees	$195	$205	$215	$226	$237	$249	$261	$274	$288	$303
Energy Fees	($54)	($56)	($59)	($62)	($65)	($69)	($72)	($76)	($79)	($83)
On-Site Poll. Cont. Equip. Operat.	$156	$164	$172	$181	$190	$199	$209	$220	$230	$242
Maintenance Labour	($120)	($126)	($132)	($139)	($146)	($153)	($161)	($169)	($177)	($186)
Maintenance Supplies	($60)	($63)	($66)	($69)	($73)	($77)	($80)	($84)	($89)	($93)
Operating Labour	$836	$878	$922	$968	$1,016	$1,067	$1,120	$1,176	$1,235	$1,297
Operating Supplies	$42	$44	$46	$48	$51	$53	$56	$59	$62	$65
Administrative Fees	$96	$100	$105	$111	$116	$122	$128	$135	$141	$148
Total Expenses Related to Fines	0	$0	$2,700	$0	$0	$0	$0	$0	$0	$0
TOTAL OPERATING SAVINGS/(COSTS)	$1,281	$1,345	$4,113	$1,483	$1,558	$1,635	$1,717	$1,803	$1,893	$1,988

Note: Costs are shown in brackets.

TABLE B-6: NET PRESENT VALUE OF PROJECT DURING ITS LIFETIME - DISCHARGE TO FRASER RIVER

Operating Year	0	1	2	3	4	5	6	7	8	9	10
Book Value	$10,000										
Undepreciated Capital Cost		$10,000	$8,000	$6,400	$5,120	$4,096	$3,277	$2,621	$2,097	$1,678	$1,342
Capital Cost Allowance		$2,000	$1,600	$1,280	$1,024	$819	$655	$524	$419	$336	$268
TAXABLE INCOME											
Operating Savings		$1,281	$1,345	$4,113	$1,483	$1,558	$1,635	$1,717	$1,803	$1,893	$1,988
Capital Cost Allowance		-$2,000	-$1,600	-$1,280	-$1,024	-$819	-$655	-$524	-$419	-$336	-$268
Terminal Loss											-$1,342
Taxable Income		**-$719**	**-$255**	**$2,833**	**$459**	**$738**	**$980**	**$1,193**	**$1,384**	**$1,558**	**$377**
PROFIT AFTER TAX											
Taxable Income		-$719	-$255	$2,833	$459	$738	$980	$1,193	$1,384	$1,558	$377
Income Tax		$180	$64	-$708	-$115	-$185	-$245	-$298	-$346	-$389	-$94
Profit after Tax		**-$539**	**-$191**	**$2,125**	**$345**	**$554**	**$735**	**$895**	**$1,038**	**$1,168**	**$283**
AFTER TAX CASH FLOW											
Profit after Tax		-$539	-$191	$2,125	$345	$554	$735	$895	$1,038	$1,168	$283
Capital Cost Allowance		$2,000	$1,600	$1,280	$1,024	$819	$655	$524	$419	$336	$268
Terminal Loss											$1,342
After Tax Cash Flow	**-$10,000**	**$1,461**	**$1,409**	**$3,405**	**$1,369**	**$1,373**	**$1,390**	**$1,419**	**$1,457**	**$1,504**	**$1,894**
NET PRESENT VALUE		**-$8,695**	**-$7,572**	**-$5,149**	**-$4,279**	**-$3,500**	**-$2,796**	**-$2,154**	**-$1,565**	**-$1,023**	**-$413**

Appendix C

Example of a Pollution Prevention Plan

BACKGROUND

The following is an example of how to complete the worksheets presented in the main body of the report. The example is for a hypothetical fish processing plant engaged in producing frozen and canned salmon.

It was assumed that the gate of the offal hopper of the plant does not close tightly and allows seepage of bloodwater from the hopper. This liquid waste stream generally has a high BOD. It was assumed that elimination of this stream is a permit requirement. In addition, it was assumed that roe is collected in plastic baskets for further processing. Blood draining from the roe drips onto the floor. Due to the high BOD of blood this relatively small wastestream contributes significantly to the BOD load discharged from the facility. An additional source of the contaminant load is due to large amounts of offal and blood which collect underneath processing equipment and conveyors in both the salmon butchering and cannning, and the salmon dressing and freezing area.

It was assumed that all offal of the fish processing plant is flumed to a sump where large chunks are removed and from where the wastewater is pumped to screens for additional solids removal. The salmon butchering and canning part of the processing plant is equipped with the following flumes:

- one main flume into which all other flumes discharge;
- one flume to collect blood/offal and rinse water from iron butchers;
- one flume to collect blood/offal and rinse water from gutters;
- one flume at each iron butcher to collect cut off fish heads; and
- one flume at each manual inspection and cleaning line.

An additional flume is used to transport all offal generated in the salmon dressing area to the main wastewater sump.

Wastestreams specific to salmon butchering and canning, or salmon dressing for freezing areas include gurry rinse water (discussed in Appendix B) and wash water, respectively. The latter is due to high-flow water sprays used to rinse blood and offal off the dressed fish.

In addition to these wastestreams, water hoses in the plant are not equipped with shut-off nozzles, and all equipment sprays are generally left running during breaks.

In the following, any comments or notes relevant to the example are presented in *italic.*

Pollution Prevention Assessment Worksheets

Worksheet No. 1 — **Program Organization**

Prepared by: J.S. Doe — Date: June 1, 1993

Process Type/Operation:
Salmon Butchering/Salmon Canning

Program Team

Name	Title	Responsibility
Program Leader J.S. Doe	Director of Engineering and Quality Control	Project management & review, facility inspection, ranking of options, report preperation, implementation plan, progress evaluation, liaison with senior management
W.E. Chu	Manager,Technical Services	Literature review, data compilation, potential P2 and water conservation areas identification, existing waste generation and water consumption levels, P2 options, technical and environmental feasibility
S.M. Johnson	Manager, Accounting	Cost analysis, economic feasibility

Pollution Prevention Goals: Compared to 1993 operating levels

1) 50% reduction of water consumption by 1998

2) 75% reduction of amount of contaminants discharged by 1998

Reporting Requirements:

Reporting to senior management after completion of each task (see timeline)

Pollution Prevention Assessment Worksheets

Worksheet No. 2 **Timeline**

Prepared by: J. Doe Date: May 12, 1993

Process Type/Operation: Salmon Dressing and Canning/Salmon Dressing for Freezing

	MONTH	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept	Oct.	Nov	Dec.
TASK	**Year**												
Compile plant data	1993						■						
Identify and obtain missing information	1993						■						
Inspect facility	1993							■	■				
Identify pot. P2 and water cons. areas	1993							■	■				
Det. ex. waste gen. and water cons. levels	1993							■	■				
Identify pollution prevention options	1993								■	■			
Conduct technical feasibility assessment	1993										■		
Conduct environmental evaluation	1993											■	
Conduct economic feasibility assessment	1993											■	■
Rank pollution prevention options	1994	■											
Prepare and review the assessment report	1994		■	■									
Determine implementation schedule	1994				■								
Implement P2 options according to plan	1994					■	■						
Evaluate pollution prevention progress	1994											■	■
Compare pre and post P2 plan waste gen.	1994											■	■

WORKSH2X.WP6

Pollution Prevention Assessment Worksheets **Worksheet No. 3**		**General Facility Information**
Prepared By: J.S. Doe		Date: June 1, 1993
General Facility Information		
Parent Organization N/A		Subject Facility
Name:		Name: West Coast Salmon Ltd.
Address:		Address: 100 Fishermen's Wharf
City:		City: Richmond
Province/Postal Code:		Province/Postal Code: British Columbia, V5H 1S0
Telephone:		Telephone: (604) 224-2345
Fax:		Fax: (604) 224-2424
Facility Production Information		
Major Operations: Fresh salmon, canned salmon		
SIC Code(s): 1021 (Fish Products Industry)		
Production Level(s) (previous calendar year): Canned: 1,5 tonnes Fresh: 200 tonnes		
Regulatory Information (check all that apply)		
✘	Liquid Waste (Effluent) Permit	Permit No.: SC-9999
✘	Air Permit	Permit No.: GVA-8888
☐	Other (please list)	Permit No.:

Pollution Prevention Assessment Worksheets

Worksheet No. 4 **Process Information**

Prepared by: J.S. Doe Date: June 17, 1993

Process Type/Operation: Salmon Butchering and Canning/Salmon Dressing for Freezing

Document		Status		
		Complete and Current? (Y/N)	Document No.	Location
1	Process Flow Diagrams	N	E92-242	Main Office
	Flow/Amount Measurements			
2	Water Usage	Y	E92-144	Main Office
3	Wastewater	Y	E92-144	Main Office
4	Product Stream(s)	Y	E92-144	Main Office
5	Offal Generation	Y	E92-144	Main Office
6	Analytical Data Wastewater Stream(s)	Y	E92-089	Main Office
	Revenue			
7	Product	Y	A92-015	Accounting
8	By-Product	Y	A92-015	Accounting
9	Offal	Y	A92-015	Accounting
10	Operating Season	Y	E92-077	Main Office
11	Waste Management Cost	Y	A92-015	Accounting
12	Water Cost	Y	A92-015	Accounting
13	Process Description	N	P90-011	Engineering
14	Operating Manuals	Y	P90-011	Engineering
15	Equipment List/ Specification	N	P90-011	Engineering
16	Piping/Instrument Diagrams	N	P90-012	Engineering
17	Site/Building/Elevation Plan(s)	Y	P90-25	Main Office
18	Environmental Audit Reports	N/A		
19	Others	N/A		
20				
21				
22				
23				
24	Type of Vessel Hold Water Disposal	Discharge with plant wastewater.		

Worksheet No. 5 - Comments

To prevent duplication, Worksheet No. 5 was completed for iron butchers only. Other equipment or processes for which this worksheet should be filled in include:

- *fish gutting and washing;*
- *manual cleaning and inspection lines;*
- *fish cutting;*
- *can filling;*
- *patching; and*
- *conveyors.*

Pollution Prevention Assessment Worksheets **Worksheet No. 5 (Page 1 of 5)**				**Waste Stream Separation**
Prepared By: W. Chu				Date: August 3, 1993
Process Type: Salmon Butchering and Canning				
Equipment/Process: Iron Butchers				
	Ensure the following is indicated on flow diagram:			Comment
1	▸ All water addition points.			
2	▸ All water discharge points.			
3	▸ All offal and blood discharge points.			
4	▸ Method of waste handling (conveyor, flume, etc.)			
5	▸ All locations where water contacts product, offal, or blood.			
	Note: A "Yes" answer to the following questions indicates a potential pollution prevention area.	Yes	No	*See Section 3.3.3.3 for potential improvements.*
6	Does offal/blood accumulate on equipment?	Yes		
7	Does offal/blood accumulate on floor below equipment?	Yes		
8	Is offal/blood in contact with water?	Yes		
9	Are water sprays used to flush offal/blood from equipment?	Yes		
10	Do valves have to be installed to control individual sprays?		No	Valves in place but not being used.
11	Would installation of low-flow nozzles reduce water consumption?	Yes		
12	Can water sprays use less pressure?	Yes		
13	Can offal be removed from water sooner?	Yes		
14	Can additional "dry" equipment cleaning methods be implemented?		No	
15	Is product sprayed with water?	Yes		
16	Is equipment adjusted incorrectly?		No	
17	Others			

Pollution Prevention Assessment Worksheets Worksheet No. 6 (Page 1 of 1) Water Conservation				
Prepared By: W. Chu				Date: August 18, 1993
Process Type: Salmon Butchering and Canning/Salmon Dressing for Freezing				
Equipment/Process: Butchering and Canning				
		Yes	No	Comment/Location
1	Are all water hoses equipped with low-flow shut off nozzles?		X	No low-flow nozzles found.
2	Are equipment sprays turned off when equipment not in use (e.g breaks, equipment cleaning)?		X	Generally all sprays left on during breaks.
3	Are water sprays adjusted or turned off individually?		X	Possible, but not done.
4	Are floors and equipment cleaned by "dry" methods prior to hose downs?		X	Some offal thrown onto floor for hosing into drains.
5	Are equipment sprays adjusted according to amount and/or type of processing?		X	Only adjusted if sprays damage fish.
6	Are leaking taps repaired immediately?		X	5 taps of 2nd manual cleaning line cannot be shut off.
7	Are gratings of floor drains kept in place?		X	
8	Are workers careful not to drop offal or product on floors?		X	(see above)
	Herring Processing:			
9	Are sexeors used for roe herring processing?			N/A
10	Is curing brine being recycled?			N/A
11	Other:			
12				
13				

Note: A "No" answer indicates a potential pollution prevention area. See Section 3.3.3.2 for potential improvements.

Worksheet No. 7 Comments

This worksheet is shown for BOD only. As the plant discharges to the GVRD the worksheet should also be completed for TSS and O&G.

DC1
Bloodwater seepage and of blood dripping onto the processing floor does not result in additional water consumption. Therefore, a value for "Water Consumption per Weight of Round Fish Processed" cannot be calculated.

DC2
Equipment sprays left on during breaks have no impact on the concentration of the wastewater, as wastewater sampling only takes place during processing.

DC3
Running hoses result in a dilution of the wastewater. However, contaminant loading is not affected.

Pollution Prevention Assessment Worksheets

Worksheet No. 7 (Page 1 of 6) **Data Compilation**

Prepared by: W. Chu Date: September 8, 1993

Process Type/Operation: Salmon Butchering and Canning

Contaminant: **BOD,** TSS, O&G, Other (circle one, if other, please indicate):

1	2	3	4	5	6	7	8
Wastestream	Before Implementation of Pollution Prevention Option					Water Consumption per Weight of Round Fish Processed	Comment (see attached page under:)
	Flow	Contaminant		Weight of Round Fish Processed	Loading per Weight of Round Fish Processed		
		Conc.	Loading				
Unit	m^3/hr	mg/L	kg/hr	t/hr	kg/t	m^3/t	
Example			$\frac{(2) \times (3)}{1000}$		$\frac{(4)}{(5)}$	$\frac{(2)}{(5)}$	
Bloodwater seepage	0.6	60000	36	4.5	8	N/A	DC1
Blood, dripping from roe	0.04	120000	4.8	3.4	1.4	N/A	DC1
Gurry rinse water	4.5	3500	15.75	3.4	4.6	1.3	
Flume water	43	2400	103.2	3.4	30	13	
Blood/offal collected on floor	1	15000	15	3.4	4.4	0.3	
Equipment sprays during breaks	16	N/A	N/A	4.5	N/A	3.6	DC2
Running hoses	3	N/A	N/A	4.5	N/A	0.7	DC3

Pollution Prevention Assessment Worksheets

Worksheet No. 7 (Page 2 of 6) **Data Compilation**

Prepared by: W. Chu Date: September 8, 1993

Process Type/Operation: Salmon Dressing for Freezing

Contaminant: **BOD,** TSS, O&G, Other (circle one, if other, please indicate):

1	2	3	4	5	6	7	8
Wastestream	Before Implementation of Pollution Prevention Option					Water Consumption per Weight of Round Fish Processed	Comment (see attached page under:)
	Flow	Contaminant		Weight of Round Fish Processed	Loading per Weight of Round Fish Processed		
		Conc.	Loading				
Unit	m^3/hr	mg/L	kg/hr	t/hr	kg/t	m^3/t	
Example			$\frac{(2) \times (3)}{1000}$		$\frac{(4)}{(5)}$	$\frac{(2)}{(5)}$	
Flume Water	4	2800	11.2	1.1	10	3.6	
Blood/offal, dripping from tables	0.01	150000	1.5	1.1	1.4	N/A	DC1
Washwater	2.5	600	1.5	1.1	1.4	2.3	

Worksheet No. 8 - Comments

The following pollution prevention options were selected:

SALMON BUTCHERING AND CANNING

Bloodwater Seepage

1. Installation of a tightly sealing gate at the offal hopper.

2. Collection of seepage for subsequent recycling.

Blood Dripping from Roe

Placement of plastic baskets in tubs to collect all dripping blood.

Gurry Rinse Water

Removal of gurry by vacuum suction as outlined in Appendix B.

Equipment Sprays during Breaks

1. Installation of a main shut-off valve.

2. Employee participation in shutting off water flows using existing valves.

Running Hoses

Installation of shut-off nozzles.

Flume Water

Option FW1

Offal handling system. Offal from the butchers and gutters would be removed from the flume water before entering the main flume.

Option FW2

Same as FW1 with an additional dewatering conveyor at the iron butchers to eliminate fluming of offal from the butchers.

Option FW3

Same as FW1 with an additional dewatering conveyor at the gutting machines to eliminate fluming of offal from these machines.

Option FW4
Same as FW1 with additional dewatering conveyors at the iron butchers and gutting machines to eliminate fluming of offal from both types of equipment.

Option FW5
Same as FW4 with additional cross conveyors to transport cut off fish heads from the iron butchers to the dewatering conveyor at these machines.

Option FW6
Same as FW4 with additional cross conveyors to transport offal from manual inspection and cleaning lines to the dewatering conveyor at the gutters.

Option FW7
Same as FW4 with additional cross conveyors to transport cut off fish heads from the iron butchers and offal from the manual inspection and cleaning lines to the dewatering conveyors at these machines.

Blood/Offal on Processing Floor
1. *Dry cleanup to prevent the mixing of water and blood/offal.*
2. *Dry cleanup and installation of chutes designed to direct offal to collection totes or conveyors.*
3. *Dry cleanup and catch and drip trays to collect blood/offal and to prevent it from falling onto the floor.*
4. *Dry cleanup and elimination of all jagged corners, rims, etc. and depressions which allow offal and blood to collect and drip on the floor.*
5. *Dry cleanup in combination with all other options to minimize the amount of blood/offal dripping onto the floor.*

SALMON DRESSING FOR FREEZING

Flume Water
Installation of offal conveyors to eliminate offal fluming.

Blood/Offal Dripping from Tables
Installation of drip trays.

Washwater
Installation of low flow nozzles.

Pollution Prevention Assessment Worksheets									
Worksheet No. 8 (Page 1 of 12)									**Environmental Evaluation**
Prepared by:							Date: December 8, 1993		
Process Type/Operation: Salmon Butchering and Canning									
Contaminant: **BOD,** TSS, O&G, Other (circle one, if other, please indicate):									
1	2	3	4	5	6	7	8	9	10
Wastestream	Pollution Prevention Option	Tech. Feas. (yes/ no/ Pilot)	Conditions Before Implementation of Option		% Reduction After Implementation of Pollution Prevention Option		Weight of Round Fish Processed During Season	Reduction in Total Loading During Season	Water Reduction During Season
			Loading per Weight of Round Fish (see Column 6, Worksheet 7)	Water Consumption per Weight of Round Fish (see Column 7, Worksheet 7)	Water Use	Loading			
Unit			kg/t	m^3/t	%	%	t	kg	m^3
Example								$\frac{(7)x(4)x(8)}{100}$	$\frac{(6)x(5)x(8)}{100}$
Bloodwater seepage	Tight seal at hopper	Yes	8	N/A	0	100	1500	12000	0
	Collect seepage	Yes	8	N/A	0	100	1500	12000	0
Blood, dripping from roe	Tubs and baskets	Yes	1.4	N/A		100	1400	1960	0
Gurry rinse water	Vacuum suction	Yes	4.6	1.3	40	80	1400	5152	728
Equip. sprays during breaks	Main Shut-off	Yes	0	3.6	100	0	1500	0	5400
	Employee Participation	Yes	0	3.6	100	0	1500	0	5400
Running hoses	Shut-off nozzles	Yes	0	0.7	100	0	1500	0	1050

Pollution Prevention Assessment Worksheets

Worksheet No. 8 (Page 2 of 12) **Environmental Evaluation**

Prepared by: W. Chu Date: December 8, 1993

Process Type/Operation: Salmon Butchering and Canning

Contaminant: **BOD,** TSS, O&G, Other (circle one, if other, please indicate):

1	2	3	4	5	6	7	8	9	10
Wastestream	Pollution Prevention Option	Tech. Feas. (yes/ no/ Pilot)	Conditions Before Implementation of Option		% Reduction After Implementation of Pollution Prevention Option		Weight of Round Fish Processed During Season	Reduction in Total Loading During Season	Water Reduction During Season
			Loading per Weight of Round Fish (see Column 6, Worksheet 7)	Water Consumption per Weight of Round Fish (see Column 7, Worksheet 7)	Water Use	Loading			
Unit			kg/t	m^3/t	%	%	t	kg	m^3
Example								$\frac{(7)x(4)x(8)}{100}$	$\frac{(6)x(5)x(8)}{100}$
Flume water	Option FW1	Yes	30	13	10	20	1500	9000	1950
	Option FW2	Yes	30	13	15	30	1500	13500	2925
	Option FW3	Yes	30	13	15	35	1500	15750	2925
	Option FW4	Yes	30	13	20	45	1500	20250	3900
	Option FW5	Yes	30	13	30	55	1500	24750	5850
	Option FW6	Yes	30	13	30	50	1500	22500	5850
	Option FW7	Yes	30	13	40	60	1500	27000	7800

Pollution Prevention Assessment Worksheets									
Worksheet No. 8 (Page 3 of 12)									Environmental Evaluation
Prepared by: W. Chu							Date: December 8, 1993		
Process Type/Operation: Salmon Butchering and Canning									
Contaminant: **BOD,** TSS, O&G, Other (circle one, if other, please indicate):									
1	2	3	4	5	6	7	8	9	10
Wastestream	Pollution Prevention Option	Tech. Feas. (yes/ no/ Pilot)	Conditions Before Implementation of Option		% Reduction After Implementation of Pollution Prevention Option		Weight of Round Fish Processed During Season	Reduction in Total Loading During Season	Water Reduction During Season
			Loading per Weight of Round Fish (see Column 6, Worksheet 7)	Water Consumption per Weight of Round Fish (see Column 7, Worksheet 7)	Water Use	Loading			
Unit			kg/t	m^3/t	%	%	t	kg	m^3
Example								$\frac{(7)x(4)x(8)}{100}$	$\frac{(6)x(5)x(8)}{100}$
Blood/offal collected on floor	Dry cleanup (DC)	Yes	4.4	0.3	50	70	1500	4620	225
	DC and offal chutes	Yes	4.4	0.3	50	75	1500	4950	225
	DC and catch and drip trays	Yes	4.4	0.3	55	75	1500	4950	247.5
	DC and smooth surfaces	Yes	4.4	0.3	55	75	1500	4950	247.5
	DC plus chutes, trays, and smooth surfaces	Yes	4.4	0.3	60	85	1500	5610	270

Pollution Prevention Assessment Worksheets

Worksheet No. 8 (Page 4 of 12) **Environmental Evaluatio**

Prepared by: W. Chu Date: December 8, 1993

Process Type/Operation: Salmon Dressing for Freezing

Contaminant: **BOD,** TSS, O&G, Other (circle one, if other, please indicate):

1	2	3	4	5	6	7	8	9	10
Wastestream	Pollution Prevention Option	Tech. Feas. (yes/ no/ Pilot)	Conditions Before Implementation of Option		% Reduction After Implementation of Pollution Prevention Option		Weight of Round Fish Processed During Season	Reduction in Total Loading During Season	Water Reduction During Season
			Loading per Weight of Round Fish (see Column 6, Worksheet 7)	Water Consumption per Weight of Round Fish (see Column 7, Worksheet 7)	Water Use	Loading			
Unit			kg/t	m^3/t	%	%	t	kg	m^3
Example								$\frac{(7)x(4)x(8)}{100}$	(6)x(5)x(8 / 100
Flume water	Conveyors	Yes	10	3.6	50	90	200	1800	(
Blood/offal, dripping from tables	Drip trays	Yes	1.4	N/A	N/A	100	200	280	(
Washwater	Low flow nozzles	Yes	1.4	2.3	50	10	200	28	23(
(All of the above wastestreams)	Semiautomatic dressing line	Yes	13	6	60	80	200	2080	72(

Worksheet No. 9 - Comments

In Worksheet No. 9 pollution prevention options are ranked. If more than one option was considered to minimize or eliminate a particular wastestream, only the option which was selected for implementation was ranked. The ranking process also reflects the fact that some options are inexpensive to implement and will result in large savings although they may not be associated with a high loading reduction. Examples of such options include:

- *collection of blood from roe in baskets;*
- *employee participation in shutting off equipment sprays during breaks; and*
- *installation of shut-off nozzles on water hoses.*

Options 12, 13, and 14 would result in reductions of the contaminant loading. However, the negative NPVs indicate that the reductions would result in net costs to the company. As other options result in savings (positive NPV), the former were excluded from the ranking process. The options with the negative NPV should be reevaluated in the future, as conditions may change causing the options to exhibit a positive NPV.

After selection and ranking of the pollution prevention options, the potential reduction in the amount of waste discharged and water consumed after implementation of all options should be estimated and compared to the pollution prevention goals identified in Worksheet No. 1. An additional review of pollution prevention options may be required if these goals cannot be met.

Specific Comments:

R1
The liquid waste discharge permit only requires the fish processing company to eliminate the seepage of bloodwater from the offal hopper. The method of achieving this requirement is to be decided by the company.

R2
The installation of shut-off nozzles on hoses does not affect the loading of contaminants discharged from the plant. The positive NPV is due to substantial water savings which will be realized as the result of implementing this option. These savings will also result in lower discharge fees due to lower discharge volumes.

R3

Option 19 is the option with the highest NPV among the options involving dry cleaning. However, in order to implement Option 19, Options 15 to 18 must be implemented. A letter was assigned to these options to indicate the implementation sequence (in alphabetical order).

R4

All three wastestreams identified for the salmon dressing area can be minimized by installation of a semiautomatic dressing line.

Pollution Prevention Assessment Worksheets

Worksheet No. 9 (Page 1 of 2) **Ranking of Options**

Prepared by: J. Doe Date: February 3, 1994

Process Type/Operation: Salmon Butchering and Canning

1	2		3	4	5	6	7
Waste Stream	Pollution Prevention Option		Potential Loading Reduction kg	Permit Requirement ?	Net Present Value $	Rank	Comments
Bloodwater seepage	1	Tight seal at hopper	12000	Yes	24500	1	R1
	2	Collect seepage	12000	Yes	22300		R1
Blood, dripping from roe	3	Tubs and baskets	1960		19000	2	
Gurry rinse water	4	Vacuum suction	5152		10056	6	
Equip. sprays during breaks	5	Main Shut-off	0		16700		R2
	6	Employee Participation	0		18500	3	
Running hoses	7	Shut-off nozzles	0		9600	4	
Flume water	8	Option FW1	9000		8100	7	
	9	Option FW2	13500		1200	11	
	10	Option FW3	15750		4700	8	
	11	Option FW4	20250		3500	9	
	12	Option FW5	24750		-600		
	13	Option FW6	22500		-2000		
	14	Option FW7	27000		-1300		

Pollution Prevention Assessment Worksheets

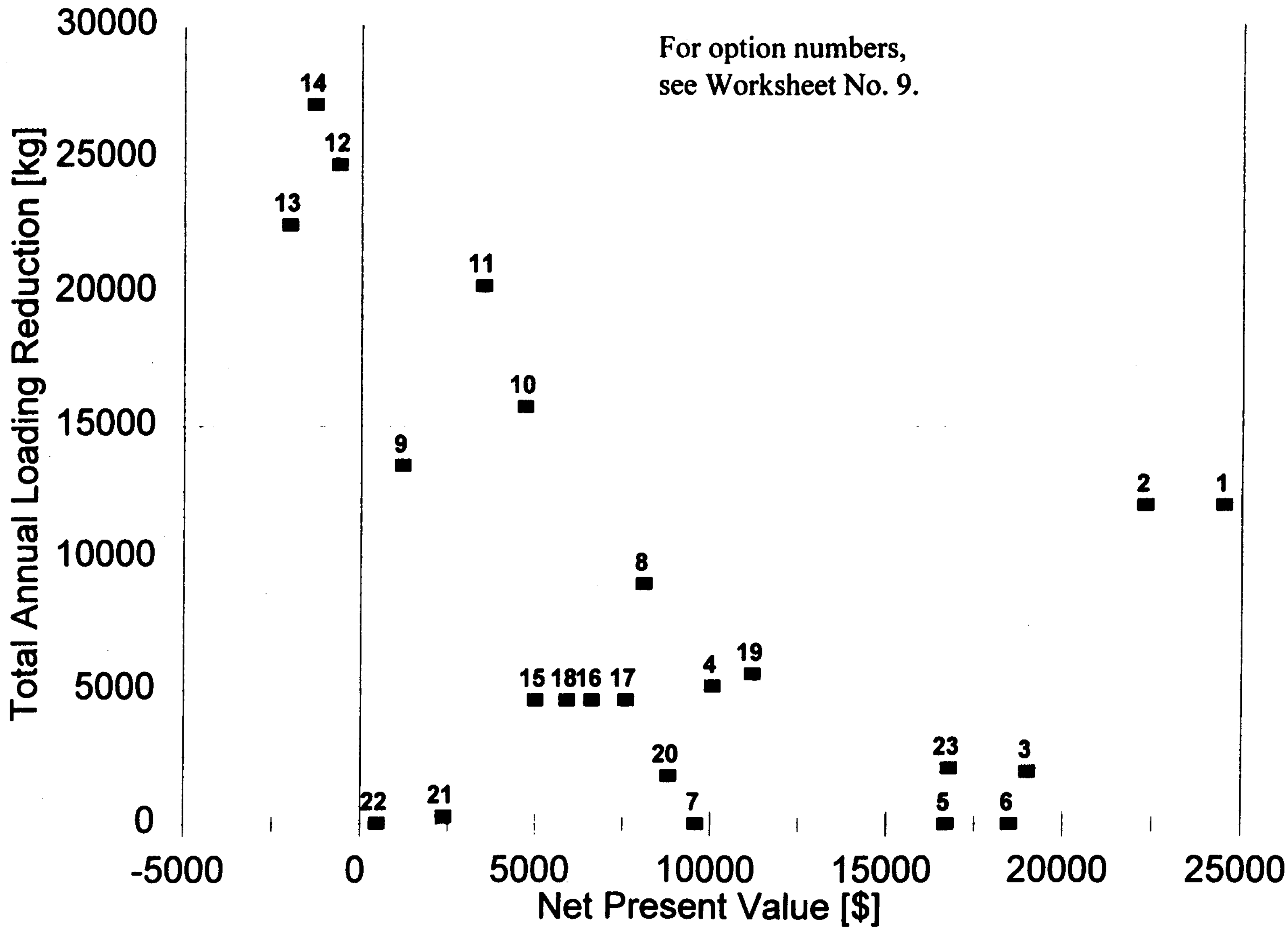
Worksheet No. 9 (Page 2 of 2) **Ranking of Options**

Prepared by: J. Doe Date: February 3, 1994

Process Type/Operation: Salmon Butchering and Canning/Salmon Dressing for Freezing

1	2		3	4	5	6	7
Waste Stream	Pollution Prevention Option		Potential Loading Reduction kg	Permit Requirement ?	Net Present Value $	Rank	Comment
Blood/offal collected on floor	15	Dry cleanup (DC)	4620		500	5A	R3
	16	DC and offal chutes	4620		6600	5C	R3
	17	DC and catch and drip trays	4620		7600	5B	R3
	18	DC and smooth surfaces	4620		5900	5D	R3
	19	DC plus chutes, trays, and smooth surfaces	5610		11200	5	R3
Salmon Dressing for Freezing Area:							
Flume water	20	Conveyors	1800		8800		
Blood/offal, dripping from tables	21	Drip trays	280		2400		
Washwater	22	Low flow nozzles	28		500		
(All of the above for salmon dressing for freezing area)	23	Semiautomatic dressing line	2080		16800	10	R4

POLLUTION PREVENTION OPTIONS - RANKING



OPT_RANK.WB1

Pollution Prevention Assessment Worksheets							
Worksheet No. 10 (Page 1 of 1)						Option Implementation	
Prepared by: J. Doe				Date: April 12, 1994			
Process Type/Operation: Salmon Butchering and Canning/Salmon Dressing for Freezing							
	Pollution Prevention Options	Estimated Implementation Date (month/year)					
		Year 1	Year 2	Year 3	Year 4	Year 5	Later
	No.	1994	1995	1996	1997	1998	
1	Tight seal at hopper	X					
3	Tubs for blood from roe	X					
6	Equipment sprays turned off by employees	X					
7	Shut-off nozzles for hoses	X					
19	Dry cleanup plus chutes, trays, and smooth surfaces	X					
4	Gurry removal by vacuum suction	X					
8	Option FW1 (offal handling system)		X				
10	Option FW3			X			
11	Option FW4				X		
23	Semiautomatic dressing line				X		
9	Option FW2					X	

Worksheet No. 11 - Program Assessment

The completion of Worksheet No. 11 is shown for wastestream "gurry rinse water" but should be completed for all wastewater streams which were investigated in detail. Of particular importance is completion of the worksheet for the final effluent, as this will show if the pollution prevention goals listed in Worksheet No. 1 have been met.

Pollution Prevention Assessment Worksheets

Worksheet No. 11 (Page 1 of 15) **Program Assessment**

Prepared by: J. Doe Date: November 16, 1994

Process Type/Operation: Salmon Butchering and Canning

Wastewater Stream: Gurry Rinse Water

After Implementation of (list options): Gurry Removal by Vacuum Suction

Total Net Present Value of all Options Affecting this Wastewater Stream: $10,056

Parameter	Concentration				Loading per weight of round fish processed				Water Use per weight of round fish processed
	BOD	TSS	O&G	Other (Specify)	BOD	TSS	O&G	Other (Specify)	
Unit	mg/L	mg/L	mg/L	mg/L	kg/t	kg/t	kg/t	kg/t	m^3/t
Before	3600	4200	700		4.6	5.3	1		1.3
After	1200	1400	233		0.92	1.06	0.2		0.78
Improvement	2400	2800	467		3.68	4.24	0.8		0.52

Normalization Factor:
(if different from "weight of round fish processed")