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Inventory and characterization
of pesticide formulators and
distributors in British Columbia.

ENVIRONMENTAL PROTECTION SERVICE, PACIFIC REGION
ENVIRONMENT CANADA

INVENTORY AND CHARACTERIZATION OF PESTICIDE FORMULATORS AND DISTRIBUTORS IN BRITISH COLUMBIA

March 1985

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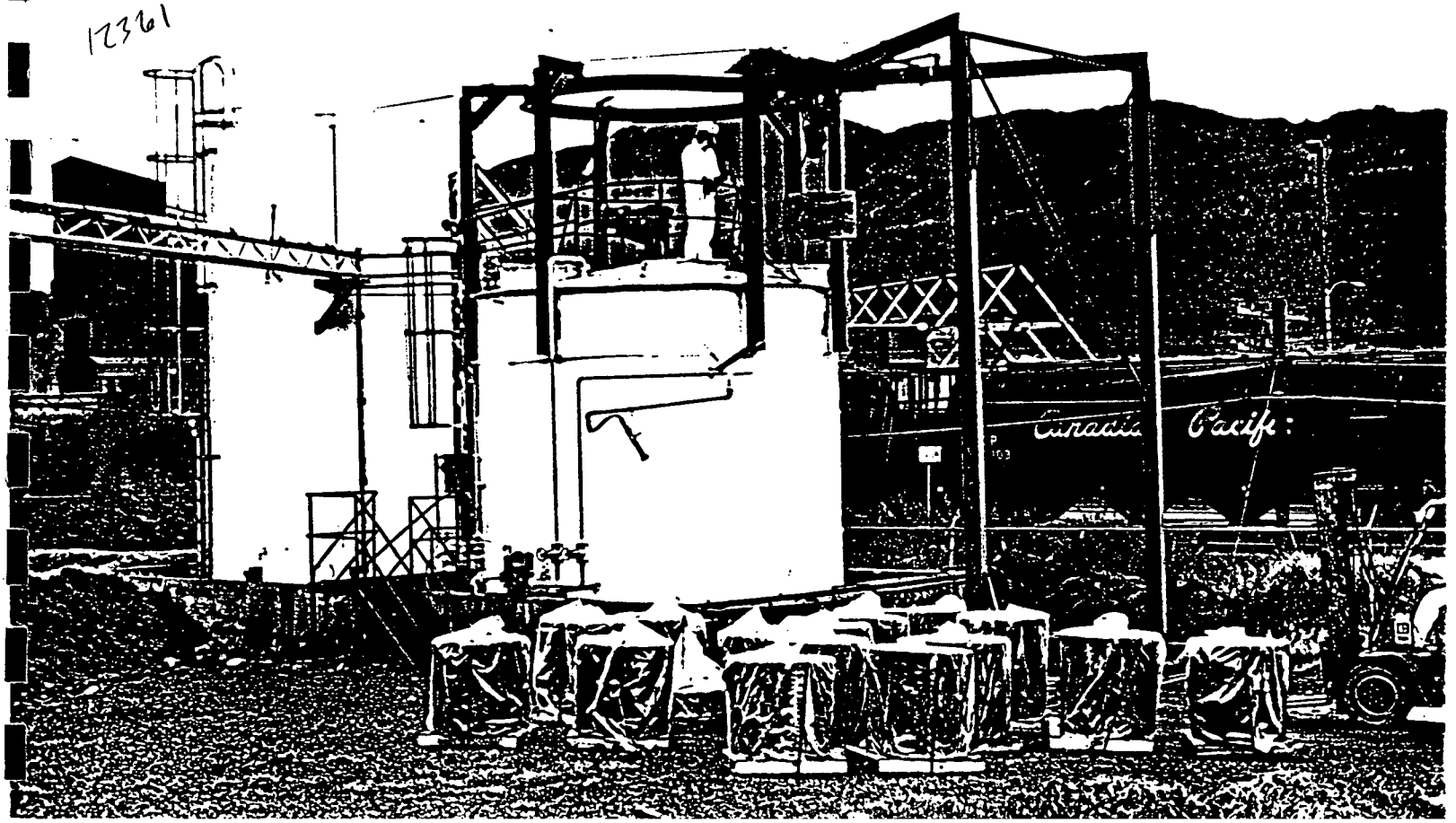

Abstract

This study was conducted on behalf of the Environmental Protection Service to inventory pesticide and distribution facilities in British Columbia. Seven formulation and three distribution facilities were assessed to evaluate existing measures of chemical control. The study evaluates the adequacy of processes and procedures to prevent human or environmental exposure to pesticides.

The study was restricted to B.C. formulators and distributors of wood treating chemicals and household and agricultural insecticides and herbicides. Formulators of bactericides (e.g. bleaches) were not included. The study indicated that pentachlorophenol and tetrachlorophenol were the active pesticide ingredients used in greatest quantity in British Columbia. In addition, chlorophenate solutions comprise the largest volume of pesticides formulated in British Columbia.

Of the household and agricultural pesticides used in British Columbia, only 10% is formulated within the province. The few formulation facilities in British Columbia are small and basic in design, when compared to facilities in Eastern Canada and the United States. Radical changes at formulation sites have occurred in the past few years to enable greater control over chemical releases to the workplace and to the environment. Potential for some emissions still exists, and these sources are identified within this report. Nonetheless, these emissions would be minimal when compared to historical releases in British Columbia which required major cleanup efforts. A major problem confronting the formulation industry is the lack of facilities within the province to handle contaminated wastes.

The distribution network for agricultural and household pesticides is extremely complex and difficult to delineate. Furthermore, controls at distribution facilities are variable, and controls at some facilities may be inadequate.

The authors concluded that regulatory agencies are not integrated in their efforts in providing regular, holistic assessments of facilities which handle chemicals with potential environmental or human health effects. Despite the many efforts and apparent overlap, many aspects of chemical assessments may be overlooked.

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CONCLUSIONS AND RECOMMENDATIONS

Conclusions

On the basis of information obtained during this study, the following conclusions were developed:

RE: PESTICIDE FORMULATION FACILITIES

1. Only a small fraction (10%) of the pesticides used in British Columbia are formulated within the Province.

2. Relative to the North American pesticide formulation industry, the formulation facilities in British Columbia are small and basic in design.

3. In general, B.C. pesticide formulators attempt to conscientiously control their emissions. Radical changes in design and operation have recently occurred within the industry to enable greater control over chemical releases to the workplace and to the environment.

4. The pesticide formulation processes utilize "closed systems" and theoretically emissions to the environment should be nil. In reality some emissions do occur in apparently minor quantities. These include:

- o solid wastes- empty bags and containers which previously held active ingredients; solids from dust collection systems; floor sweepings; and, spent filters and filtered materials.
- o air emissions- exhausts from ventilation systems and dust collection systems; and, dusts from unvented work areas.
- o liquid emissions- equipment cleanup waters which cannot be reused; housekeeping washdown waters; and, surface runoff waters from areas which were exposed to pesticide formulations.

5. Assessments of surface runoff waters and air emissions (i.e. dust collection system emissions) at existing pesticide formulation facilities have not occurred.

6. Solid wastes are usually disposed at a secure landfill site in the United States. Despite recommendations of the Canadian Agricultural Chemical Association, at least one British Columbia agricultural and household pesticide formulator is disposing of active ingredient container bags and wrappings at a municipal landfill. Two formulators of wood treatment chemicals likewise dispose of their chlorophenol wrappings at municipal landfill sites. Furthermore, drums from one formulator are reclaimed by a third party for unknown subsequent use.

7. Major releases of pesticides to the environment have occurred at two British Columbia formulation facilities. The releases indicate the potential effect such facilities may have on the environment, and highlight the importance of proper design and operational controls.

8. Recent measures to improve worker safety at pesticide formulation facilities are primarily due to: the initiative of companies; the results of worker-management joint assessments of in-plant safety precautions; and/or recommendations of the Workers' Compensation Board. Some of the measures include regular biomonitoring programs, educational sessions, and emergency response procedure development. These measures are variable within the B.C. industry. For the industry as a whole, the study team judged that worker safety precautions are reasonably good and significantly improved over practices which existed as little as 5 years ago.

9. Some concerns still exist with regard to worker safety at some facilities and these concerns include: improving worker education; the need for contingency planning; worker hygiene precautions; adequacy of ventilation systems; and, labelling of storage containers, work tanks and process lines.

10. The Workers' Compensation Board and the Health Department of Richmond Municipality have been the most active of all regulatory agencies for interaction with and assessment of British Columbia pesticide formulation facilities. Agriculture Canada activities are limited to product and labelling assessment, and those limited activities in part are due to the 1.1 man-years allocated in 1984 for Pest Control Product Act implementation in the Province. The Waste Management Branch of the B.C. Ministry of Environment is familiar with all formulation facilities, however its activities have been restricted to the control of actual emissions, if any. The Branch would have further involvement if, and when, regulations are passed under the existing Waste Management Act. The Branch could then assess waste storage practices, assure proper transport and disposal of wastes, and assure that proper spill control precautions are in place. The Pesticide Control Branch of the provincial Ministry of Environment restricts its assessment activities to retail facilities. Both British Columbia agricultural and household pesticide formulation facilities also act, in part, as retailers and Branch representatives have interacted with the facilities to assure that facilities are licensed and personnel involved with sales are certified and that products are stored properly. The Environmental Protection Service (Environment Canada) has interacted with formulators on occasions which include definition of spill cleanup measures, assessment of plant design for one new facility with respect to chemical control, and a survey with Agriculture Canada on pesticide quantities in use.

The interests of the many agencies are restricted, in part by Statute, and the interests may overlap and/or exclude various facets of environmental and worker health protection. As a result holistic assessments of chemical use and handling do not occur, and it is probable that some aspects of chemical control may "fall through the cracks".

RE: PESTICIDE DISTRIBUTION FACILITIES

11. The distribution network for wood treating formulations in British Columbia is readily identifiable. On the other hand the distribution network for agricultural and household pesticides is much more complex, with a variable infrastructure which is defineable for only a short time period. A specific active ingredient many be found within many formulations and one formulation may be handled by several distributors. Some distributors function as: formulators; distributors to distributors; distributors to retailers; and, as retailers.

12. Only larger distribution facilities for household and agricultural pesticides were visited during this study, and precautions at these facilities for worker safety and control of emissions to the environment were judged to be adequate. However various representatives of government, industry and trade associations expressed concern that some distribution facilities which store large quantities of pesticides may not have adequate precautions. The areas of expressed concern included: labelling; worker education and safety precautions; storage of pesticides in vicinity of materials which are either non-compatible or which are used for human consumption and/or use; storage of chemicals within structures built of wood or in underground facilities; and, ultimate disposal of spilled materials.

13. Potential emissions from household and agricultural pesticide distribution facilities are minimal, and should under proper conditions be non-existant. Most formulated products observed during this study were packaged in containers less than 50 pounds in capacity. No bulk pesticide formulations were stored at any of the visited household and agricultural pesticide distribution sites. As a result, spills of household and agricultural pesticides could be readily contained because of the relatively small package sizes.

14. Wood treatment chemicals are distributed in bulk form, and an accidental spill during storage, loading and unloading, and transport could result in widespread dispersal to the environment. One such incident has occurred within the Province.

15. Wood treatment chemicals are transported to end-users by means of trucks which are owned/leased and operated by distributors. The operators are trained to respond to spill emergencies, and will report inappropriate end-use practices to the distributors.

16. Agricultural and household pesticides are usually transported by commercial trucking companies or by end-users from distribution facilities to the retailers or places of end-use. A few representatives of industry expressed "internal fears" about the possible responses or lack of response which may result upon a spill situation during transport of their products by truckers who may be unfamiliar with their cargoes.

Recommendations

1. Despite the many agency assessments of the pesticide industry, it appears that many facets of this industry (and for that matter many other industries) have been overlooked in terms of chemical safety assessment. Some of the assessments overlap, although agencies are frequently not aware of each other's activities. In the interests of properly evaluating chemical handlers such as the pesticide formulation industry and in the interests of optimizing and minimizing the time of industry in cooperating with such evaluation efforts, it is recommended that federal, provincial and municipal authorities develop some means of integrating their efforts in providing regular, holistic assessments of facilities which handle chemicals with potential environmental or human health effects.

2. It is recommended that a more thorough investigation of all major pesticide distribution and storage facilities in British Columbia be undertaken to assess aspects such as design, operation, worker education and safety, and disposal practices. To facilitate the investigation, it is recommended that the Environmental Protection Service review the situation with other government agencies concerned with the distribution and storage of pesticides in British Columbia.

3. Until the Regulations of the 1984 Waste Management Act are placed into effect, it is recommended that disposal requirements be defined for empty pesticide containers. It is further recommended that drum recyclers be assessed with regard to fate of drum washings and control over eventual reuse of washed containers.

4. It is not recommended that a draft code of good practice be written for the industry on the basis of this study, because the formulation industry in B.C. cannot be considered as representative for the Canadian industry. It is however recommended that similar studies be carried out in Eastern Canada, particularly Ontario. Following the Eastern Canada assessment, the need for an industry code of practice could then be evaluated.

1 INTRODUCTION

1.1 Pesticides

"Pesticides" are defined as chemicals to control "pests" such as algae, birds, bacteria, fungi, weeds, insects, mites, snails and slugs, nematodes, fish, and rodents. Control of such pests has many positive benefits such as enhanced food production and disease control. Pesticides function by causing biological effects on a target species, with the most frequent result being death of the target species. Pesticides are rarely species specific and uncontrolled releases may result in undesireable consequences to other species, including man. As a result, Canadian federal and provincial government agencies have enacted legislation and subsequent regulations with the intent of enabling the use of pesticides and minimizing undesireable consequences as a result of the formulation, use and disposal of pesticides. Relevant legislation which is applicable to the pesticide industry in British Columbia includes:

- FEDERAL LEGISLATION
  - Pest Control Products Act
  - Environmental Contaminants Act
  - Fisheries Act
  - Canada Water Act
  - Transport of Dangerous Goods Act

- PROVINCIAL LEGISLATION
  - Pesticide Control Act

A review of the Acts is found within the Province of British Columbia Ministry of Environment's "Handbook for Pesticide Applicators and Pesticide Dispensers" (1) and a joint Federal department report entitled "Pesticide Use and Control in Canada"(2).

1.2 Review of concerns in B.C.

In 1973, the Government of the Province of British Columbia formed a "Royal Commission of Inquiry into the Use of Pesticides and Herbicides". The Commission reviewed pesticide use patterns in British Columbia, the implications of the use patterns to the environment and human health, and the adequacy of existing control measures. In a presentation at a Commission hearing, Environment Canada described 17 pesticide-related fish kill incidents which occurred in British Columbia from 1957 to 1973. In one instance, approximately 3,000,000 fish were killed and at another site a kill of "10 tons" of fish occurred. Circumstances which resulted in the kills included reasons such as: vandalism of containers; improper storage procedures; improper disposal; and, improper application procedures (3).

In view of such data, and data presented by other agencies and investigators, the Commission (4) provided many recommendations which included:

- o the withdrawal of several "exceedingly toxic" pesticides from use in British Columbia;
- o control on sales of pesticides for use in the home and garden;
- o improvement in Provincial arrangements to handle pesticide accidents;
- o more definitive regulations regarding transport of pesticides within the Province;
- o specific regulations for formulating plants and storage warehouses to minimize effects of spills, and;
- o regulations for disposal of empty containers and effluent emissions.

An assessment of responses to the Commission's recommendations was beyond the scope of this study. Controls on sales of pesticides for use in the home and garden have indeed occurred since the time of the Commission's report, however actions do not appear to have occurred with respect to the recommendations for regulations on formulating plants and storage warehouses, and on disposal of empty containers and effluent emissions.

Since the Commission recommendation in 1975, regulatory agencies in British Columbia have dealt with several additional pesticide releases which have resulted in environmental degradation and/or subsequent effects to biota. The release incidents have included:

- o 26 documented spills of chlorophenates at wood protection facilities of which several have resulted in fish kills and charges under the Fisheries Act;
- o dispersal of organophosphate and chlorinated hydrocarbon pesticides in surface runoff waters and yard soils of a pesticide formulation facility, resulting in restricted future use of the site and;
- o dispersal of chlorophenate solution from a formulator's storage tank which resulted in a kill of hundreds of fish downstream from the site.

1.3 Purpose of this study

The Environmental Protection Service has developed a Toxic Chemical Management Program with the intention of minimizing environmental impacts from the manufacture, use and disposal of toxic chemicals. Under this program, the Environmental Protection Service (Pacific and Yukon Region) for example, has developed and distributed a technical recommendations document to define design and operational features which will minimize the potential for releases of chlorophenates from wood protection facilities. The document was developed by a joint working group of government, industry and union representatives, and addresses design, operation, and maintenance of facilities, as well as emergency control procedures. The technical recommendations document was a product of concerns of the Environmental Protection Service with regard to the number of chlorophenate spills from wood protection facilities which were noted previously in Section 1.2.

In 1984, a large release of chlorophenate solution from a formulating facility occurred. Considerable local and national news media coverage of the release followed because the spill resulted in the death of many fish immediately downstream of the facility. The spill eventually reached a marine bay. Several weeks later, two dead grey whales were found in the bay and more news coverage followed. No correlation between the spill and the whale deaths was proven. Nonetheless, this incident and the yard contamination at the pesticide formulation facility (described in Sections 1.2 and 3.4.3) resulted in concerns about storage and handling procedures of pesticides at both formulating and distribution facilities. As a result, the Environmental Protection Service-Pacific Region contracted Envirochem Services of Burnaby, British Columbia to:

- Inventory and characterize each pesticide formulating facility in British Columbia.
- Review types of products formulated and distributed in British Columbia.
- Provide a general overview of the pesticide distributors and pesticide distribution patterns in British Columbia.

- o Assess the adequacy of engineering design and operational procedures at formulation facilities with regard to chemical control.
- o Determine points of chemical release during formulation, storage and transportation of pesticides; determine disposal practices; review existing monitoring data; and, subsequently assess potential environmental and health risks.
- o Provide an assessment of the need for concern in British Columbia.

1.4 Study approach

British Columbia companies engaged in the formulation of pesticides were identified in consultation with the Environmental Protection Service, the B.C. chapter of the Canadian Agricultural Chemicals Association , and with representatives of various government groups such as Agriculture Canada and the British Columbia Ministry of Environment. In addition, various trade directories and the Agriculture Canada pest product registration list were reviewed.

In joint consultation with the Scientific Authority, it was decided that the project would focus on formulators of household, agricultural and wood treating pesticide products. Formulators of germicidal products such as bleaches would not be considered during this project. Furthermore, large scale operations were to be given highest priority.

Only seven formulators within the intended project scope were found and arrangements were made with the intent to visit all seven facilities. Environment Canada did not use legislative authority to obtain information and cooperation of industry was voluntary. Only one facility refused cooperation.

Within the original work plan, the contractor proposed to assess four chemical sales and distribution firms which store and distribute large quantities of chemicals which may not necessarily include pesticides. The intent was to attain a general assessment of precautions taken by chemical distributors with regard to storage facilities and handling practices. During the course of the study, the work plan was changed to include only pesticide distribution facilities. Four distribution facilities were visited.

In addition to site visits, representatives of Agriculture Canada, the B.C. Pesticide Control Branch, the B.C. Waste Management Branch, Workers' Compensation Board, Richmond Municipal Health Department and the B.C. Chapter of the Canadian Agricultural Chemicals Association were visited for discussions relevant to this project.

Individual assessments of formulation facilities were provided to the Scientific Authority, and these documents have confidential status because of their reference to trade quantities and process procedures. The first draft of this summary report was submitted to various industry and government personnel for review to assure that interpretations were accurate.

2 PESTICIDE USE PATTERNS IN B.C.

As mentioned in Section 1, the pest control chemicals of interest to this project are fungicides (wood treating) and, insecticides and herbicides (household and agriculture).

2.1 Wood treating chemicals

2.1.1 OVERVIEW OF USE AND DISTRIBUTION

Treating chemicals considered in this study are categorized in two groups: wood preservation chemicals, and wood protection chemicals.

WOOD PRESERVATION CHEMICALS

"Wood preservation" involves the pressure-impregnation of wood with chemicals for the long-term preservation of the structural intergrity of wood. Four chemical treatment processes (chlorophenol dissolved in oil, creosote, aqueous solutions of chromated copper arsenate and aqueous solutions of ammoniacal copper arsenate) are currently used at 15 wood preservation facilities in British Columbia. A review of wood preservation chemical useage in British Columbia is provided in a report by Henning and Konasewich (5). The report indicated that in 1983: 10 facilities utilized 1,700,000 kilograms of 50% liquid concentrate CCA (chromated copper arsenate); 2 facilities used 400,000 imperial gallons 3% ammoniacal-copper-arsenate (ACA) solution; 4 facilities used 445,000 kilograms of pentachlorophenol; and, one facility used 930,000 imperial gallons of creosote. The locations of useage and handling practices are detailed in the above noted report which is entitled "Characterization and Assessment of Wood Preservation Facilities in British Columbia". Since the 1983 study, a new creosote treatment facility has initiated operation near the town of Ashcroft and another CCA treatment facility is under construction near Radium, British Columbia.

The report of Henning and Konasewich (5) indicated that future quantities of useage were expected to be relatively constant for pentachlorophenol,

creosote, and ammoniacal-copper-arsenate (ACA). Increased useage of CCA was predicted. Compared with quantities reported to the Royal Commission of Inquiry into the Use of Pesticides and Herbicides in 1973 (4), pentachlorophenol useage in 1983 has increased by at least 600% (64,300 kg used in 1973 vs 445,000 kg in 1983) and creosote useage has increased by approximately 63% (570,000 imperial gallons in 1973 versus 930,000 imperial gallons in 1983).

Table 2.1 provides an overview of wood preservation chemical supply, distribution and use in British Columbia. Wood preservation chemicals are formulated at the end-user site or imported in pre-mixed form from sources identified in Table 2.1. Therefore wood preservation chemical formulation is not addressed in this report.

WOOD PROTECTION CHEMICALS

"Wood protection" refers to the short-term protection of the surfaces of freshly-sawn wood from discoloration by sapstain and mould fungi. Presently the pesticide chemical, sodium tetrachlorophenate, is used in 86 of 87 sawmill facilities and export terminals in British Columbia. Another chemical, 2-(thiocyanomethylthio)-benzothiazole (TCMTB), is used at one facility and continued formulation and use at the time of this study was doubtful. As a result, this report restricts discussion of wood protection chemicals to chlorophenates. A March 1985 decision of Reichhold Chemicals of Tacoma, Washington to permanently halt the manufacture of tetrachlorophenol will significantly affect the situation because the company was the sole source of registered tetrachlorophenol, which was subsequently used to prepare sodium tetrachlorophenate solutions.

Despite the pending and uncertain change in wood protection chemical useage in British Columbia, this report provides an overview of chlorophenate use and distribution in British Columbia as of March 1, 1985. It is anticipated that until other wood protection chemicals are registered in Canada, pentachlorophenol from Vulcan Materials Company (manufactured at Wichita, Kansas) and Rhone-Poulenc (manufactured at Pont de Claix-Isere, France) will

TABLE 2.1: WOOD PRESERVATION CHEMICAL SUPPLY, DISTRIBUTION AND USE IN B.C.

CHEMICAL	FORM [AS DELIVERED]	SUPPLIER	B.C. USE [1983]
CCA	● CONCENTRATE [50% AND 72%] DRUMS, BULK	KOPPERS-HICKSON [ATLANTA, GEORGIA] OSMOSE [MEMPHIS, TENNESSEE]	1,700,000 KILOGRAMS [50% CONCENTRATE USED AT 11 SITES]
ACA	● ARSENIC ACID [75% SOLUTION] DRUMS ● COPPER OXIDE [PELLETS] DRUMS ● AMMONIA SOLUTION BULK	J.H. BAXTER TACOMA, WASHINGTON. J.H. BAXTER LOCAL	400,000 GALLONS 3% ACA SOLUTION USED AT 2 SITES
PCP	● PCP SOLID [86% PURITY] BLOCKS, PELLETS	REICHHOLD CHEMICAL LTD. TACOMA, WASHINGTON [TO MARCH, 1985] VULCAN CHEMICALS WICHITA, KANSAS [AFTER MARCH, 1985] RHONE-POULENC PARIS, FRANCE [AFTER MARCH, 1985]	445,000 KILOGRAMS [SOLID, USED AT 4 SITES]
CREOSOTE	● LIQUID BULK	DOMTAR CHEMICALS HAMILTON, ONTARIO	930,000 GALLONS [1 SITE] 190,000 GALLONS [NEW SITE, 1984]

be used as the major wood protection ingredient in British Columbia. The latter company, Rhone-Poulenc, also manufactures a tetrachlorophenol product which contains 53% tetrachlorophenol and 40% pentachlorophenol. The product was "on-order" by at least one formulator during the time of this study.

Figure 2.1a presents an overview of penta- and tetrachlorophenol supply, distribution and use in British Columbia as of March, 1985 . Figure 2.1b presents an overview of probable supply and distribution patterns after April 1, 1985 .

The total annual use of chlorophenol compounds in British Columbia is estimated at 725,000 kilograms. Approximately 405,000 kilograms/year of predominantly tetrachlorophenol compounds are used to formulate aqueous solutions of chlorophenates for use in wood protection. The chlorophenate solutions are distributed as concentrates which contain from 7 to 27% chlorophenols (by weight). Figure 2.2 indicates the user locations throughout the province. The largest numbers of users are found within the areas of the Lower Mainland (26 users), Vancouver Island (21 users), and Prince George (12 users).

2.1.2 FORMULATORS AND DISTRIBUTORS

As of March 1, 1985, it was estimated that 57% of chlorophenate wood protection solutions used in British Columbia was formulated within the province at two facilities which are located in the Lower Mainland. The balance was imported from the U.S.A. as premixed solution. The imported solution was distributed from a single facility which is also located in the Lower Mainland. In all cases, the source of supply of active ingredient (tetrachlorophenol solid) was the Reichhold Chemicals Inc. manufacturing facility located in Tacoma, Washington.

The principal actors in the formulation and distribution of chlorophenate solutions are identified in Figure 2.1a. The scope of activities at each of these facilities is summarized on the following page.

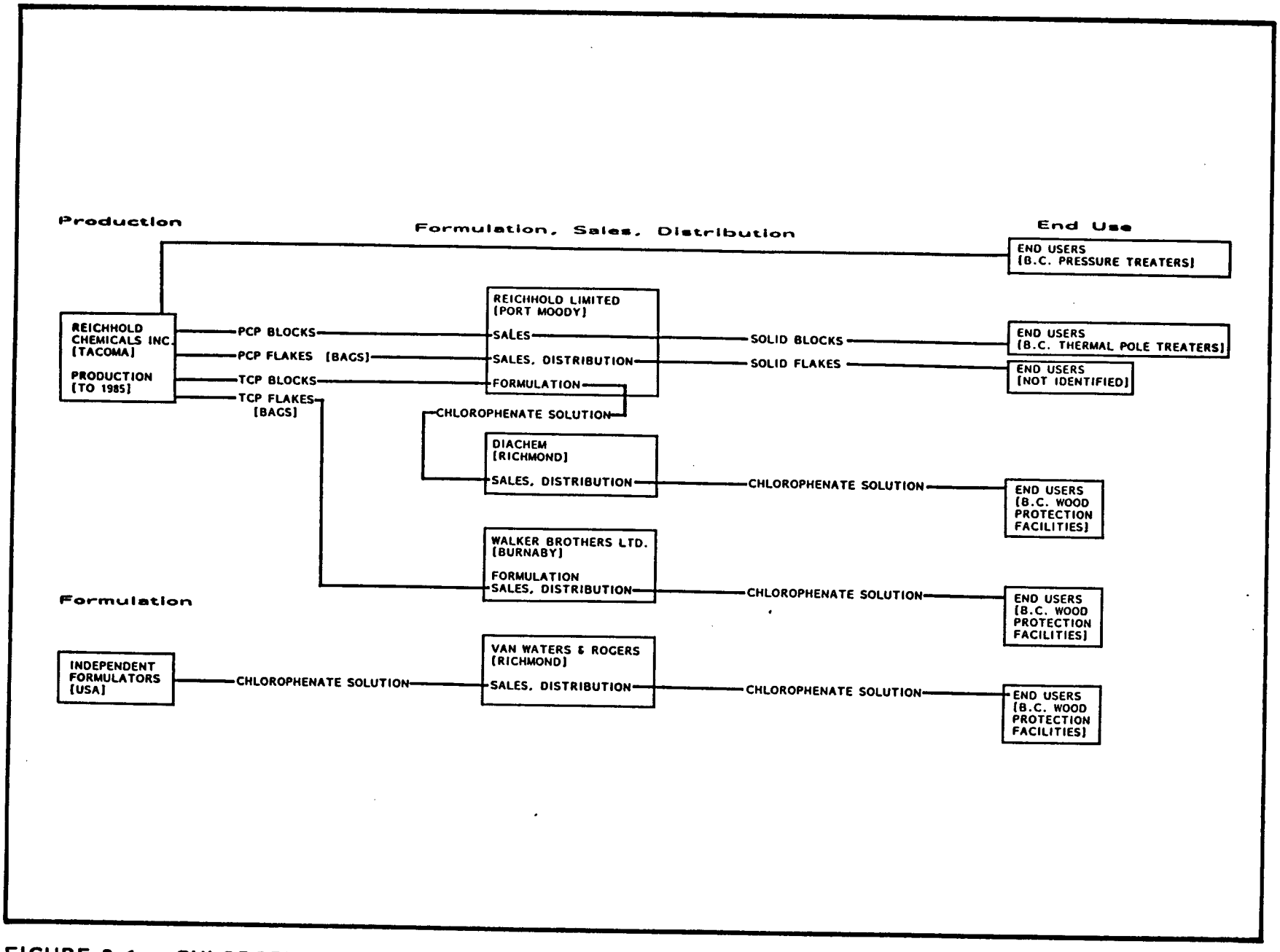


FIGURE 2.1a: CHLOROPHENOL DISTRIBUTION IN BRITISH COLUMBIA [To March 1985]

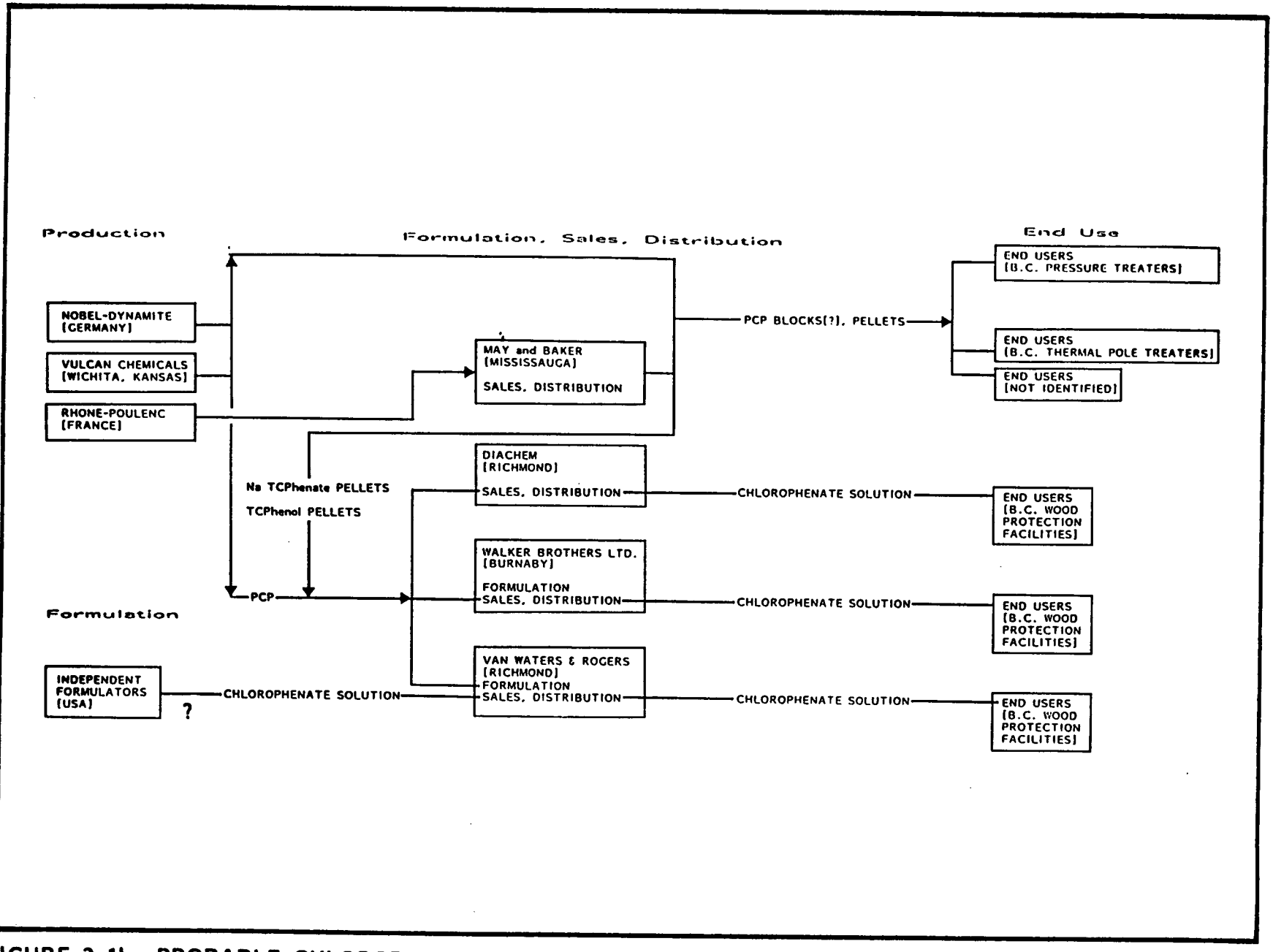


FIGURE 2.1b: PROBABLE CHLOROPHENOL DISTRIBUTION IN BRITISH COLUMBIA [AFTER MARCH, 1985]

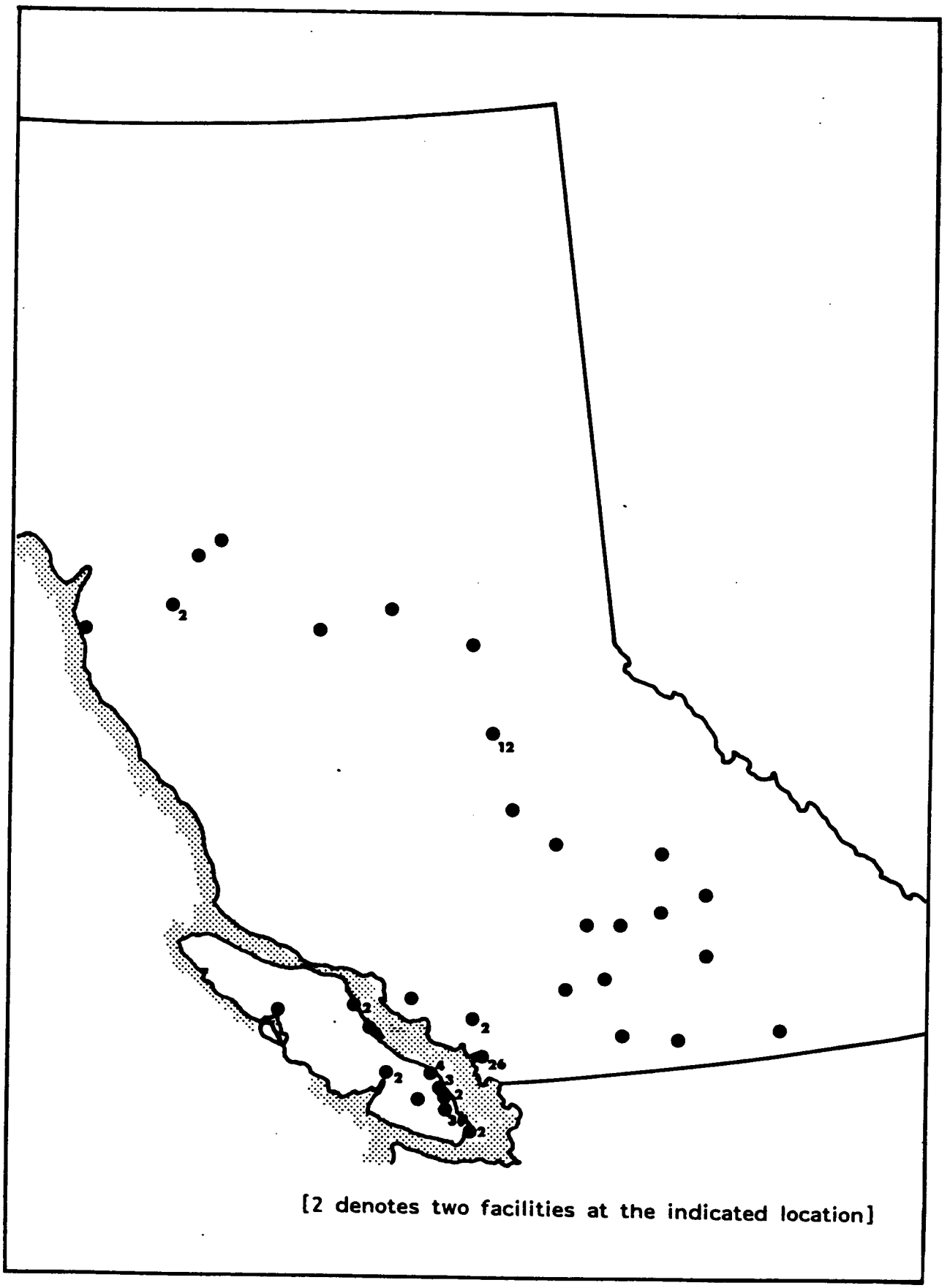


FIGURE 2.2: LOCATION OF CHLOROPHENATE USERS IN BRITISH COLUMBIA

Subsequent to April 1, 1985, the status of chlorophenate formulation was still undefined, due to the suddenness of the Reichold decision to halt production of chlorophenols. Short-term stockpiles of chlorophenols were at hand, however future supply would have to be obtained from either Vulcan Chemicals (Wichita, Kansas) or Rhone-Poulene (France). The French product is distributed in Canada by May and Baker Canada Inc. of Mississauga, Ontario. At the time of final preparation of this report, it appeared that the Reichold Ltd. facility of Port Moody would no longer be used to formulate chlorophenates. Diachem had plans underway to formulate at its Richmond facility. Van Waters and Rogers were still uncertain whether formulation would occur at its Richmond facility or at its previous formulation site (American Tar) in Washington. It also appeared that the Rhone-Poulenc tetrachlorophenol product was the favored active ingredient for use in B.C.

REICHHOLD LIMITED is a multi-divisional Canadian Company which serves industrial markets throughout North America. The Company is a major producer and/or distributor of resins, industrial and oil and gas chemicals, printing equipment, printing inks and agricultural chemicals. The Port Moody Plant employs 70 persons and produces several chemical products including:

- o sodium tetrachlorophenate solutions (until March, 1985)
- o formaldehyde
- o urea formaldehyde
- o emulsion glues (principally polyvinylacetate emulsions)
- o alkyd resins
- o unsaturated polyesters (fiberglass resins)
- o treated fiber products

Until March 1985, Reichhold formulated tetrachlorophenate solution on contract for Diachem (exclusively), using tetrachlorophenol active ingredient imported as 1000-2000 pound solid blocks from Reichold Chemicals Inc (RCI), Tacoma . The formulation of tetrachlorophenate solutions was a minor activity in the context of total operations at the Port Moody Plant, requiring employee efforts equivalent to a fraction of one full-time employee. Mixing activities normally utilized two employees for a part day approximately once per month.

Reichhold Limited also acted as agent for RCI in the sales and distribution of pentachlorophenol (solid blocks) for use by thermal pole treaters, and for the sales and distribution of small quantities of pentachlorophenol flake (bagged) to unspecified end users.

In March, 1985 a corporate decision was made by RCI to cease production of chlorophenols by April 1, 1985. The decision was totally unexpected by all formulators and end-users. As a result the Reichold Port Moody facility was to be no longer used for the formulation of chlorophenates. It is the understanding of the study team that the formulation equipment would be cleaned and that the wash-waters were intended for re-use by one of the other formulators.

DIACHEM is a diversified formulator of specialty chemical products with formulating facilities located in the Riverside Industrial Park in Richmond. The Company employs 18 people at this site and produces an estimated 240 distinct products including:

- o sapstain control agents and/or components (the "Diatox" and "Seabrella" products)
- o slimicides and sanitizers
- o cleaners and detergents
- o water treatment chemicals
- o defoamers
- o pulp and paper industry chemicals
- o food and beverage industry chemicals
- o lumber end paint
- o oil field chemicals
- o dust suppressants
- o sewage treatment plant chemicals
- o mining industry detergents

"Diatox", and other biocides (slimicides and sanitizers) are major product lines which comprise an estimated 35-40% of the Company's total business. As

noted previously, until March 1985, the "Diatox" tetrachlorophenate sapstain control solution was formulated at Reichhold's Port Moody Plant. The solution was sold and transported to end users by Diachem directly from the Reichhold site. Following the loss of Reichold as a supplier of chlorophenols and chlorophenate solutions, it is anticipated that Diachem will formulate chlorophenate solutions at its Richmond plant. Diachem also prepares an aqueous "Seabrella" formulation which consists of waxes and color pigment. Normally the Diachem application systems mix "Seabrella" with "Diatox" at the site of the end-users. However, on occasion an end-user may request a premixed Seabrella and chlorophenate formulation which is referred to as "Seabrella-T". Prepared volumes of "Seabrella-T" were said to be low. Slimicides constitute the other products of Diachem which are registered under the Pest Control Products Act and these products are discussed briefly in Section 2.3 of this report.

WALKER BROTHERS LTD. is a division of SCM (Canada) Limited which produces a wide range of paints, coatings and chemical products. The Burnaby plant employees 26 people and produces the following product lines:

- o "Woodsheath", a tetrachlorophenate sapstain control solution
- o end sealers for lumber
- o travel stain control packager (for lumber shipped by rail)
- o plywood stains
- o inks

The first three product lines (as listed above) constitute the major formulating activities at this site, with "Woodsheath" formulation requiring about one third of production efforts. Batches of "Woodsheath" are mixed on most working days at this plant. Walker Brothers Ltd. was likewise affected by the Reichold decision to cease production of chlorophenols. Alternative sources of chlorophenols have been found by the company.

VAN WATERS AND ROGERS is a subsidiary of UNIVAR, a U.S. owned and based company. Van Waters and Rogers operates a large chemical warehousing and distribution center in Richmond. The Company stores, repackages, formulates

and/or distributes a wide variety of bulk and containerized chemicals. Tetrachlorophenate solution was delivered in bulk to the site from the American Tar Company, a formulator based in the State of Washington. The Van Waters and Rogers solution was and is sold and distributed under the trade name of "Woodbrite" to end users in British Columbia.

Subsequent to the Reichold decision, Van Waters and Rogers located alternate sources of chlorophenols. As of March 1985, it was uncertain whether long-term formulation of chlorophenates would occur at the American Tar Company or at the Van Waters and Rogers Richmond. To fulfill short-term requirements, formulation was initiated at the Richmond site.

2.2 Agricultural and household pesticides

There are few publicly available reports which overview the use and distribution of agricultural and household pesticides in British Columbia. One report was published in 1975 by the Province of British Columbia Royal Commission of Inquiry into the Use of Pesticides and Herbicides (4). A more recent overview on the use of pesticides in B.C. agriculture is provided within a 1983 in-house report of the British Columbia Workers' Compensation Board (6).

An overview of use and distribution of agricultural and household pesticides was beyond the terms of reference of this study. However a brief overview is required to provide a perspective for evaluating the potential concerns related to the industry in this province. This overview is based on a review of existing publicly available information and discussions with key individuals in the industry.

The generalized pattern of distribution of household and agricultural pesticides in British Columbia is shown in Figure 2.3. which traces the distribution of pesticides from the point of formulation to the ultimate user. The primary distribution paths are shown by the bold arrows and the arrow width is proportional to the estimated total quantity of pesticides involved at each step in the distribution. Minor distribution paths are indicated by line arrows. Activities within and outside of the province are distinguished by the dotted boundary line.

Updated information is not publicly available in total quantities of pesticides used in B.C. for agricultural and household purposes. It was estimated within the B.C. Workers' Compensation Board report (6), that pesticides used in B.C. farms represented only 3% of the value of pesticides used in all Canadian farms. The data presented within the Workers' Compensation Board Report (6) show that at least 487,500 pounds of pesticide active ingredients were sold during 1983 for use in British Columbia agriculture. This quantity is comparable to the Royal Commission of Inquiry (4) figure of 402,632 pounds of pesticides sold for agricultural, home and garden uses in British Columbia during 1973.

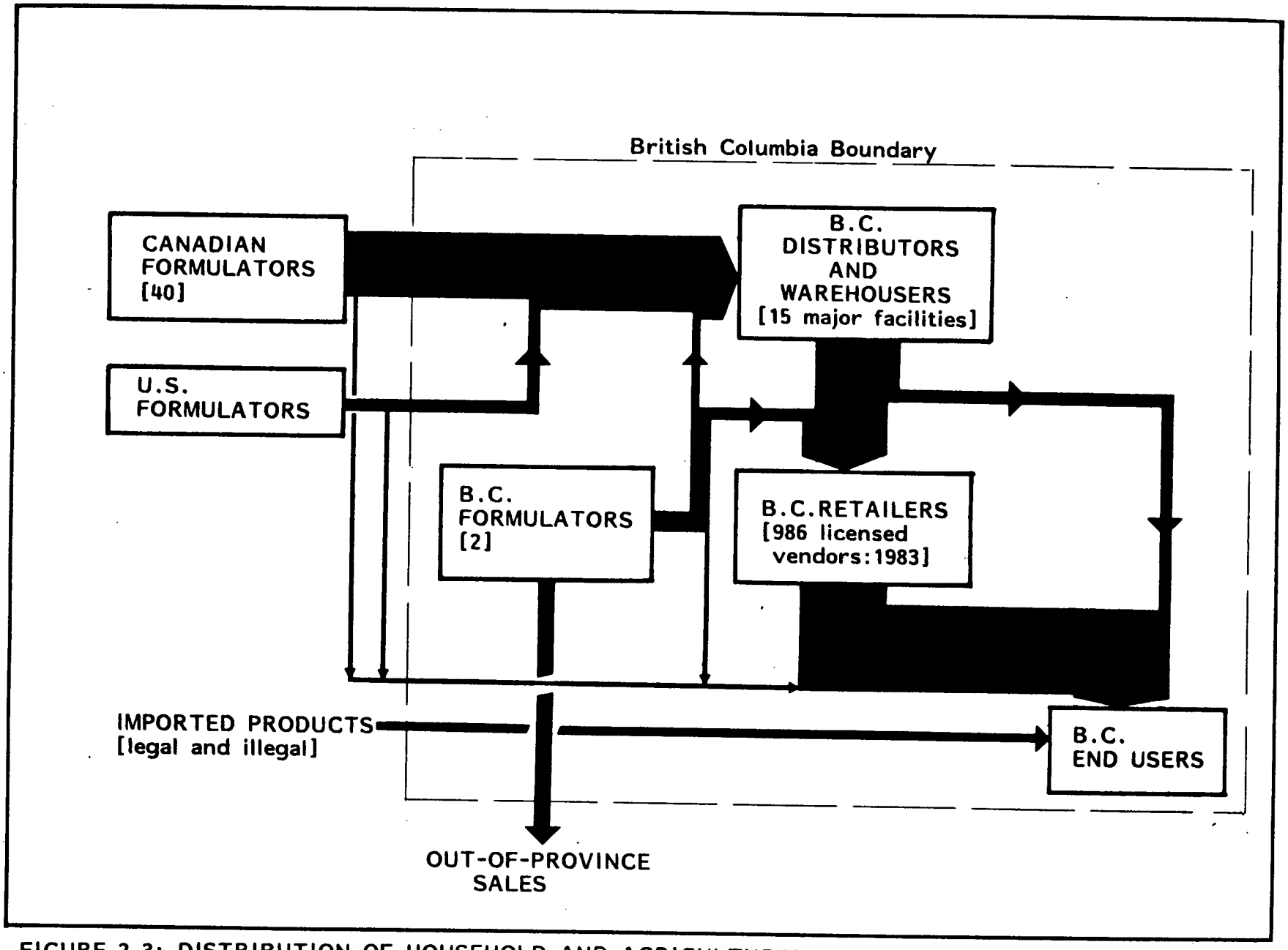


FIGURE 2.3: DISTRIBUTION OF HOUSEHOLD AND AGRICULTURAL PESTICIDES IN BRITISH COLUMBIA

2.2.1 OVERVIEW OF USE AND DISTRIBUTION

AGRICULTURAL PESTICIDES

General use patterns of agricultural pesticides can be determined from the 1981 Statistics Canada Census of Agriculture, which assessed the use of herbicides, fungicides, insecticides and soil sterilants in eight regions of British Columbia (7). The census in part, reported the "area to which sprays or dust were applied in 1980 for control of weeds and brush and/or insects and disease". The results of the survey which are summarized in Table 2.2 indicate that herbicide-treated land in the Peace Region represents the largest fraction of herbicide-treated land in British Columbia. For agricultural insecticide useage, the numbers of agricultural users and acreage are highest in the Okanagan and Mainland Regions. The data do not consider the strength of application or frequency of repeat applications.

The only publicly available data on the various types and quantities of pesticides used in British Columbia are found within the Final Report of the Royal Commission of Inquiry into the Use of Pesticides and Herbicides (4) and the Workers' Compensation Board report entitled "Pesticides in B.C. Agriculture" (6). A comparison of the 1973 data of the Commission (4) and the 1983 data of the Workers' Compensation Board indicates that organophosphate and carbamate insecticide chemicals have largely replaced the use of organochlorine chemicals. Using data from the two reports, Table 2.3 identifies pesticides in major use within British Columbia for agricultural purposes. Data from the 1973 Commission report (4) are used only when no quantitative data are found within the 1983 Workers' Compensation Board report. Other pesticides known to be used in the Province, are identified in Table 2.4. These pesticides are listed separately because quantitative data were not available or the quantities are less than 5000 pounds. The Statistics Canada Census of Agriculture indicates that $9.9 million was spent by 6,700 British Columbia farmers in 1980 for pest control chemicals (7). Tables 2.3 and 2.4 show only a portion of the 150 different active ingredients in 750 formulations which are registered and available for use in B.C. agriculture. A more complete listing can be found within the report of the Royal Commission of Inquiry into the Use of Pesticides and Herbicides (4).

TABLE 2.2: AGRICULTURAL USE OF PESTICIDES IN BRITISH COLUMBIA
[1981 STATISTICS CANADA DATA]

	AGRICULTURAL DISTRICT							
	KOOTENAY	OKANAGAN	THOMPSON	MAINLAND	ISLAND	CARIBOO	OMINECA	PEACE
HERBICIDES								
USE [#FARMS]	117	1383	108	1290	185	27	119	510
% OF B.C. TOTAL [3739]	3	37	3	35	5	1	3	14
USE [ACREAGE]	12969	33021	3353	43358	4016	1096	4346	197220
% OF B.C. TOTAL	4	11	1	14	1	1	2	66
OTHER PESTICIDES								
USE [#FARMS]	161	2401	56	1005	182	8	16	56
% OF B.C. TOTAL [3885]	4	62	1	26	5	1	1	1
USE [ACREAGE]	2241	30725	871	25818	2099	113	91	14706
% OF B.C. TOTAL	3	40	1	34	3	1	1	19

TABLE 2.3 MAJOR PESTICIDES IN AGRICULTURAL USE IN BRITISH COLUMBIA

ACTIVE INGREDIENT	ESTIMATED SALES IN BC (lbs)	CLASSIFICATION	USE
Dichloropropene	82,500	Organochlorine	Nematocide
Diazinon	40,000	Organophosphate	Insecticide
Atrazine	40,000	Triazine	Herbicide
Azinphos-methyl	40,000	Organophosphate	Insecticide
DNOC, Dinosebamine	40,000	Nitrophenolic	Herbicide
Captan	40,000	Organochlorine	Fungicide
Dithiocarbamates (Maneb, Zineb)	32,000	Dithiocarbamates	Fungicides
Endosulfan	25,000	Organochlorine	Insecticide
Thiocarbamates (EPTC, Triallate)	24,000	Thiocarbamates	Herbicides
Sulfur	*21,000		Fungicide Acaricide
Malathion	20,000	Organophosphate	Insecticide
Sodium chlorate	*18,000		Herbicide
Glyphosate (Roundup)	16,000	Organophosphate	Herbicide
Phosalone, Phosmet	*12,000	Organophosphate	Insecticide, Acaricide, Molluscicide
Paraquat	10,000	Bipyridinium	Herbicide
Carbaryl	10,000	Carbamate	Insecticide
Parathion	*9,000	Organophosphate	Insecticide
Metaborate	*8,000		Herbicide
Carbofuran	*5,000	Carbamate	Insecticide Nematocide
Dimethoate	5,000	Organophosphate	Insecticide

All quantities were obtained from 1983 report of the British Columbia Workers' Compensation Board (6), with exception of astericked (*) values which are obtained from the Royal Commission Report (4).

TABLE 2.4 OTHER PESTICIDES IN AGRICULTURAL USE IN BRITISH COLUMBIA

ACTIVE INGREDIENT	CLASSIFICATION	USE
Barban (Carbyne)	Carbamate	Herbicide
Benomyl	Carbamate	Fungicide
Chlordimeform	Imidamide	Acaricide, Insecticide
Cyhexatin	Organotin	Miticide
Diclofop methyl	Organochlorine	Herbicide
Difenzoquat	Pyrazole	Herbicide
Dodine		Fungicide
Fensulfothion	Organophosphate	Insecticide Nematocide
Mevinphos	Organophosphate	Insecticide, Acaricide
Phenoxy compounds (2,4-D, MCPA)	Organochlorine	Herbicides
Phosalone	Organophosphate	Insecticide
Propargite		Acaracide
Permethrin, pyrethrins	Pyrethroids	Insecticides
Simazine	Triazine	Herbicide
Thiophanate-methyl	Carbamate	Fungicide
Trifluralin (Treflan)	Nitrophenolic	Herbicide

More recent data could be obtained from the results of the 1984 joint effort by the Pesticides Division of Agriculture Canada and the Commerical Chemicals Branch of Environment Canada, whereby data on the sales of 89 active pesticide ingredients was requested. This information is considered confidential and is not available for the purposes of this study.

HOME AND GARDEN PESTICIDES

Reports on actual quantities of home and garden pesticides used in the province of British Columbia are not publicly available. The publicly available documentation of the Royal Commission (4), groups sales data for both agricultural and household pesticides. It is anticipated that quantities of such pesticides sold in various regions of the province are dependent upon populations within the regions. As a result, the highest sales of home and garden pesticides are expected within the Lower Mainland Region. Smaller sales quantities would be expected in the Okanagan, Vancouver Island, and Omineca/Peace Regions, respectively. Assuming an approximate correlation between sales and numbers of licenced pesticide vendors, similar trends are also observed whereby the Lower Mainland Region has 434 licensed vendors, Okanagan Region has 232, Vancouver Island Region has 203, and the Omineca/Peace Region has 117 licensed vendors (8).

To illustrate the types of home and garden pesticides which are currently sold in British Columbia, Table 2.5 summarizes a local formulator's product list (9).

2.2.2 FORMULATORS AND DISTRIBUTORS

Formulators and distributors in British Columbia frequently handle both agricultural and household pesticides. Some active ingredients are used for both agricultural and household pesticide formulations. As a result, discussions on formulators and distributors are presented jointly for agricultural and household pesticides.

TABLE 2.5: EXAMPLES OF HOME AND GARDEN PESTICIDES FORMULATED AND USED IN BRITISH COLUMBIA

PESTICIDE TYPE	ACTIVE INGREDIENTS
INSECTICIDES	DIAZINON, MALATHION, METHOXYCHLOR, PYRETHRIN, ROTENONE, CARBARYL
FUNGICIDES	BENOMYL, COPPER, SULFUR, FORMALDEHYDE
INSECTICIDE/ FUNGICIDE COMBINATIONS	CARBARYL, CAPTAN, METHOXYCHLOR, ROTENONE
WEED AND GRASS KILLERS	MECOPROP, MCPA, 2,4-D
SOIL STERILANTS	BROMACIL, AMITROLE
SPECIALTY PRODUCTS	CPA, ASPHALT SOLIDS
HOME INSECT CONTROL	DIAZINON, PROPOXUR, CHLORPYRIFOS
BAITS	METALDEHYDE, WARFARIN, SULFAQUINOXALINE
HOUSEPLANT CARE	PIPERONYL BUTOXIDE, DICOFOL, ROTENONE, PYRETHRIN

FORMULATORS

The Canadian Agricultural Chemicals Association (10) estimated that 96% of the active ingredients formulated in Canada are imported. There are approximately 15 major formulators in Canada. It is assumed that all formulators in Canada are registrants of products registered under the Pest Control Products Act. Registered products could also be obtained from registrants outside of Canada or could be formulated in or outside of Canada on behalf of a Canadian registrant. Products from all formulators are distributed throughout Canada through a variety of channels to the end-users. The complexity of the distribution system is discussed later in this chapter.

As indicated in Figure 2.3 it is estimated that no more than 10% of the household and agricultural pesticides used in British Columbia are formulated within the Province (4, 11). Ninety percent of the imported products come in prepackaged form from Eastern Canada. A majority of the remaining 10% of formulated imported products are received from American formulators who have registered their products with Agriculture Canada. An unknown and supposedly small fraction is imported legally and illegally by users.

A review of the Agriculture Canada "Compendium of Pest Control Products Registered in Canada" (12) indicates that there are 22 registrants and applicants with British Columbia addresses. The registrants and applicants and the types of products registered are listed in Table 2.6. Six of the 22 facilities have products which could be considered under the category of household and agricultural pesticides. One of the facilities, Laters Chemicals Ltd. formulates for Green Leaf Garden Supplies. Two of the facilities formulate only one product.

Of the 22 registrants and applicants, only one facility can be classified as a major household and agricultural pesticide formulation facility: Later Chemicals Ltd. of Richmond. Most of the formulations prepared at the facility are oriented towards the household market.

TABLE 2.6 PEST CONTROL PRODUCTS REGISTRANTS AND APPLICANTS WITH BRITISH COLUMBIA ADDRESSES

NAME AND ADDRESS	NUMBER REGISTERED PRODUCTS	TYPE OF PRODUCT(S)
Alliance Int'l Sales Ltd., Vancouver	1	Disinfectant
Axis Oil Corporation, Winfield	1	Dormant oil (miticide)
British American Chemical Co., [Now a division of Savolite] Burnaby	3	Slimicides
Camosum Chemical and Equipment, Burnaby	2	Disinfectants
Cloverdale Paint and Chemical, Surrey	2	Disinfectants
Diachem Industries Ltd., Richmond	1 5 1	Disinfectant Slimicides Wood treatment
Edoco Healey Technical Products, Vancouver	1	Wood treatment
Flecto Coatings Ltd, Richmond	11	Wood treatment (in stains)
General Paint and Wall Covering, Vancouver	3	Wood treatment
Green Leaf Garden Supplies,	37	Miticides, fungicides, insecticides, herbicides, rodenticides, molluscicides
Growers Supply Company,	1	Lime-sulfur (Insecticide, fungicide, miticide)

TABLE 2.6 (CONT'D)

Later Chemicals Ltd.,	122	Herbicides, insecticides, fungicides, miticides, rodenticides, wood treatment
The Mandate Roman Company, [Now Chlorax] Richmond	2	Disinfectants
Miller Supply Ltd, Saanichton	1	Disinfectant
Noxall Products Ltd., Vancouver	16	Pet powders, (Insecticides, rodenticides, molluscicides, miticides, animal repellants)
Reichold Limited, Port Moody	2	Wood treatment (for manufacturing purposes only)
Savolite Chemical Co. Ltd. Delta	4	Disinfectants
Sipco Industrial Products, Richmond	1	Disinfectant
Smith Barregar Ltd., Vancouver	3	Wood treatment
Van Waters and Rogers Ltd.,	21	Insecticides, wood treatment, herbicides, acaricides, fungicides, swimming pool algaecides and bactericides
Walker Brothers Ltd., Burnaby	5	Wood treatment
Weldwood of Canada Ltd., Vancouver	3	Wood treatment

LATER CHEMICALS LTD. is owned equally by CHEVRON CANADA LTD. and by EQUITIE'S CONSULTANTS (1972) LTD. (i.e. the GREENLEAF organization). Its Richmond facility serves to: formulate liquid and solid pesticides for agricultural and household use; repackage formulated pesticides on behalf of another company; and, warehouse pesticide formulations for distribution. Approximately 50 active ingredients are used to formulate 100 products which are placed in containers which range from small household sizes to drum sizes for agricultural use. The formulations are prepared by the use of 3 liquid and 2 solid blending and mixing tanks. Pesticides are formulated for only six months per year at this facility.

The next largest household and agricultural pesticide formulator in British Columbia is VAN WATERS AND ROGERS, which is a subsidiary of the U.S. based UNIVAR CORPORATION. The operation is much smaller than Later Chemicals Ltd. Although Van Waters and Rogers sells approximately 150 pesticide formulations, few are actually formulated or repackaged at the site. Of the 17 products for which the company has registration under the Pest Control Products Act, only seven are formulated at the site, and these seven formulations are liquid mixtures. Dusts are formulated by low bid subcontractors, who at the time of this study were located in Nebraska. For the remainder of the 150 products, the company serves only as a distributor for other formulators. Pesticide formulation at the Van Waters and Rogers facility reportedly occurs over a period of approximately 20 days per year. A single 250 gallon mixing and blending tank is used for the formulation process.

DISTRIBUTORS

Unlike the simplistic distribution of pesticides such as chlorophenates, the distribution patterns of agricultural and household pesticides in British Columbia are extremely complex. A user of agricultural pesticides can obtain a particular active ingredient formulation from a retailer, a distributor to retailers, or from the formulator. In other words, within the industry, there is not a clear or consistent delineation between the role of formulator, distributor and retailer. In fact, a particular company may perform all three roles, and categorization as either formulator, distributor or retailer may be misleading.

As an example, one of the largest distributors of pesticides in the Province handles the products of as many as 40 formulators. In addition, the facility formulates one product. This distributor is a major supplier to two large cooperatives and has a large retail outlet within the distribution site. Furthermore, this distributor may bulk purchase a pesticide in such quantities that other distributors who require smaller quantities may purchase from this distributor rather than the actual formulator.

A particular active ingredient can be found in products of many formulators. For example, a particular formulation containing atrazine can be obtained from as many as 8 formulators. The distributor's selection of source is generally based on lowest cost and frequently without much loyalty to particular formulators. On the other hand, a product of a formulator can be handled by several distributors.

Without any attempt to illustrate the many possible interactions among the industry, Figure 2.4 outlines the major registrants and distributors of agricultural and household pesticides used in the Province. Most registrants can be assumed to be Canadian formulators, although exceptions do occur. Pfizer, for example, does not formulate any products in Canada. The names of major registrants and distributors were obtained from discussions with various sources and are believed to be relatively complete. The intent of Figure 2.4 is to define the principal actors in the British Columbia pesticide industry and to portray those facilities which handle and store large quantities of agricultural and household pesticides. It is cautioned however that some retail facilities may have quantities of pesticides in storage which may exceed the quantities in storage at sites designated as distribution or storage areas (13).

As noted previously, the pathways of distribution of active ingredients and formulations from the manufacturers to distributors are complex. Most products used in British Columbia are prepackaged at sites outside of the province, and in most instances are transported directly from the formulator to a distributor. However, at least six formulators located in Eastern Canada store pesticide formulations in British Columbia for eventual supply to distributors

and/or retailers. These formulators and the two British Columbia formulators are identified in Figure 2.5, along with the facilities used for storage. It should be noted however that some distributors may have more of a formulator's product in storage than a storage facility designated for this particular formulator. For example, Grower's Supply in Kelowna may have more Pfizer products in storage than St. George's Moving and Storage facilities which are known to serve as Pfizer's storage facilities in the Province.

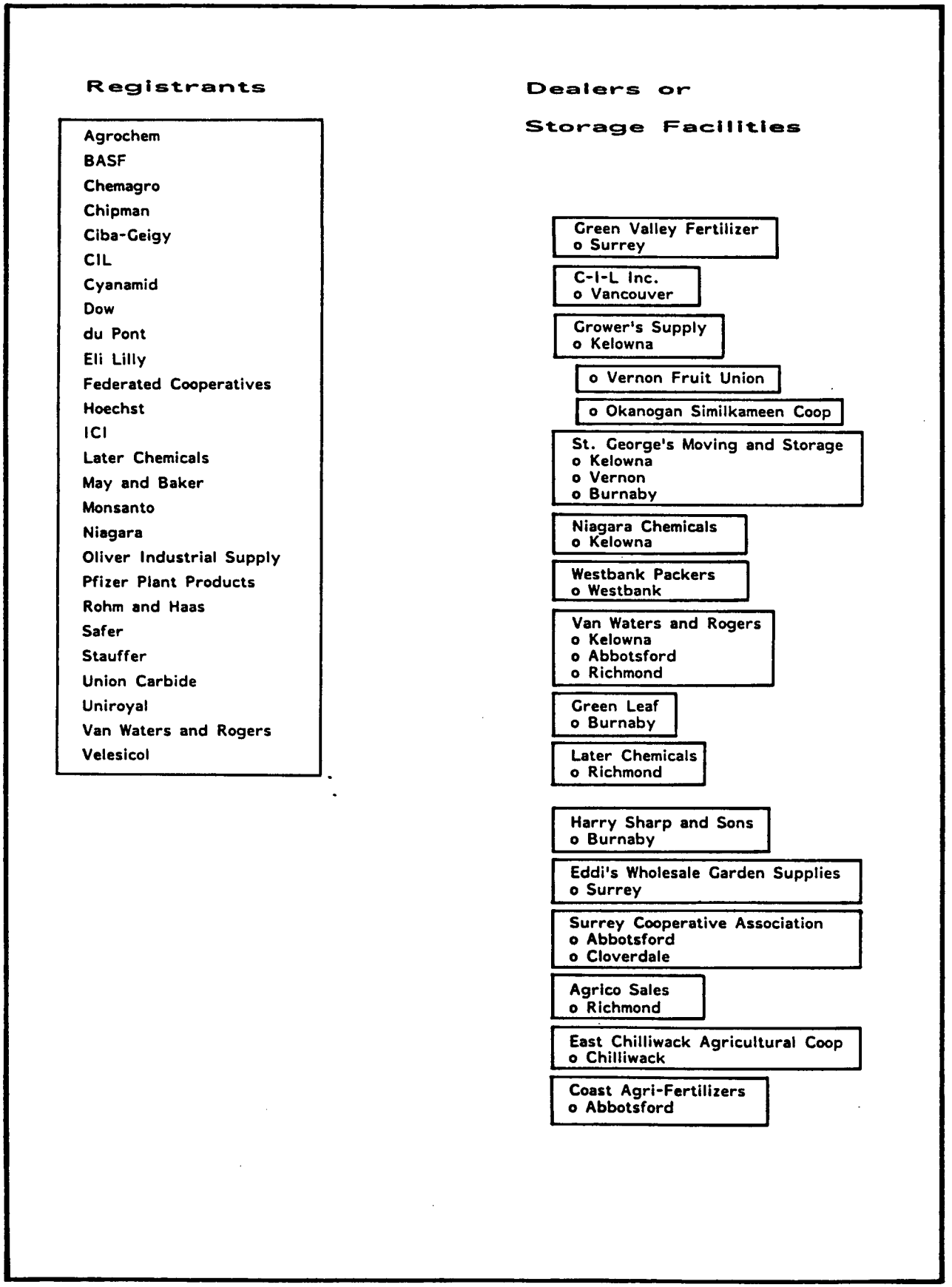


Figure 2.4: MAJOR REGISTRANTS AND DISTRIBUTORS OF PESTICIDE FORMULATIONS USED IN BRITISH COLUMBIA

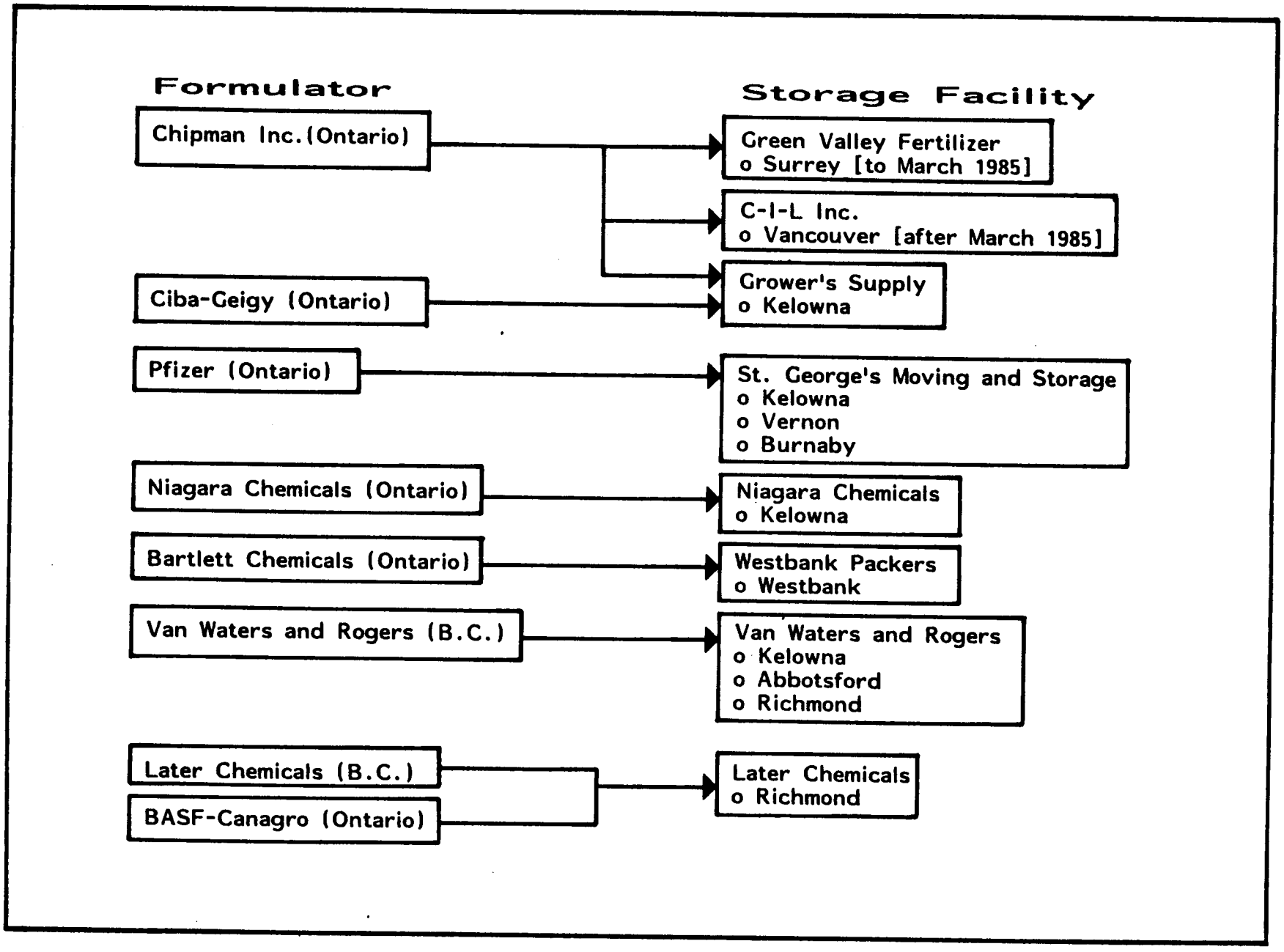


FIGURE 2.5: PESTICIDE FORMULATORS WITH DESIGNATED STORAGE FACILITIES IN BRITISH COLUMBIA

2.3 Other pesticides

HERBICIDES (RIGHT-OF-WAY CLEARANCE)

The Royal Commission of Inquiry into the Use of Pesticides and Herbicides in the Province of British Columbia (4) commissioned a study to identify all users of pesticides in the Province (14). The study showed the following distribution for the total insecticide and herbicide use in the Province:

- o 58% for agriculture, home and garden
- o 21% by British Columbia Railway
- o 6.4% by British Columbia Hydro and Power Authority
- o 5.7% by the forest industry
- o 5.4% by the Department of Highways
- o 2.6% by Canadian Pacific Railway and,
- o 1% by Canadian National Railway

Most of the pesticides used outside the scope of "agriculture, home and garden" were herbicides for right-of-way clearance. It is not known whether the user pattern has changed since the above 1973 figures were published.

The Commission report (4) also noted that large scale users such as a particular railroad company may by-pass distributors in the Province and purchase products directly from formulators.

SLIMICIDES

Slimicides are used by companies such as pulp and paper mills. Two slimicide formulators are listed in Table 2.6 and active ingredients used in their formulations (12) include:

- o Methylene bis(thiocyanate)
- o Nabam
- o 2-mercaptobenzothiazole
- o sodium salt of cyanodithioimido carbonate
- o bis (trichloromethyl) sulfone
- o sodium dimethyl dithiocarbamate

3 PESTICIDE FORMULATION IN B.C

3.1 Overview of facilities

Pesticide formulation facilities in British Columbia are few and vary considerably in sophistication with respect to operation and design. Compared to U.S. facilities described by U.S. EPA (15) and NIOSH (16), British Columbia facilities are small in scale and relatively unsophisticated in design. Formulation facilities in the Province vary in size from an operation which uses a single 250 gallon mixing tank for the preparation of several formulations to a facility which uses a 5,000 gallon mix tank for the preparation of a single formulation.

As noted in Section 2 (and within the context of the definition of "pesticides" used for the purpose of this report), there are only two household and agricultural pesticide formulators in British Columbia who on a relative basis for the Province could be classified as major formulators. One of the formulators prepares liquid and solid formulations which are predominantly for the household market. The second formulator prepares only liquid formulations which are predominantly used for agricultural purposes. Several other formulations are prepared in a relatively small scale at other facilities. These facilities are identified in Table 2.6 of Section 2, on the basis of information from the Pest Control Products Compendium (12).

As described in Section 2.1, there were three formulators of chlorophenate wood treating chemicals in British Columbia and one formulator of TCMTB solutions (as of March 1985).

3.2 Process descriptions

Pesticide formulation has been described as the "art and science employed in transformation of a manufactured pesticide chemical into a form that an applicator can readily use in the field" (17). The science of the formulation process requires the application of physical-chemical principles, engineering skills, and familiarity with factors such as odor, corrosion, solubility, surface activity, vapor pressure, flammability, compatibility with additives and other formulations, stability, toxicity, and residue characteristics. The ability to successfully consider all these factors has been described by Riegel (17) as the "art".

Formulations can be classified into three groups: water-based; solvent-based; and, dry-based. The first two groups are subsequently referred to as liquid formulations. Most commonly, liquid pesticide household and agricultural formulations employ oil in water emulsions (i.e., the pesticide system is dispersed in a continuous aqueous phase), which are mixed with either of nonionic, anionic, and cationic surfactants. The choice of solvent and surfactant systems involve the art and knowledge of colloid and surface chemistry as well as the toxicology and residue characteristics of the adjuvants. Formulation requires a compromise between effective dispersion of the emulsion during the spraying operation, and the quick breaking of the emulsion upon the surface of foliage. In other cases, high surfactant activity is desired to perform the biological objective. Therefore a single pesticide chemical may be prepared under many types of formulations.

Preparation of liquid wood treatment chemical formulations is usually less complex. Chlorophenol formulations are made by simply dissolving solid chlorophenol in caustic solution. The resultant sodium chlorophenoxide solution may be shipped directly to the user or may be blended with waxes, color and buffers for special applications such as high pressure spray treatment. TCMTB preparation is more complex whereby glycol ether and aromatic solvents are blended with TCMTB concentrate paste.

Solid formulations are prepared as "dusts" and wettable powders. "Dusts" are essentially mixtures of: ground fine particles of active ingredients; inerts such as talc and clay; and, adjuvants. The resultant mixture is applied by direct dusting of the plant surface or the soil. Wettable powders are solids which are suspended in water for subsequent spraying on foliage. Formulations of wettable powders consist of: inert additives such as clay, celite or talc; comminuted active ingredients; surfactants; and, other additives such as suspending agents, stickers, spreaders and antiflocculants. Liquid active ingredients can also be transformed to wettable powders by dispersing the liquid onto fine particles of an absorbent clay, celite or talc. The surfactants and other additives provide the physical chemical properties necessary for optimum dispersibility in water and adhesion to foliage and insects.

Water-based and solvent-based formulation processes are essentially similar, and consist of (with reference to Figure 3.1):

- o a pumping system for liquid active ingredients
- o a dumping or loading system for solid active ingredients
- o a solvent storage and pumping system
- o an agitator
- o a pumping system for addition of emulsifiers, deodorants, etc.
- o a storage system for formulated product
- o an unloading system for bulk shipments or an individual container filling system.

All six formulators visited for the purposes of this study, prepare liquid formulations. The four wood protection chemical formulators use water-based processes, although methanol may be added for protection against freezing and wax-buffer-pigment systems may complement formulations used for spray applications. The two agricultural and household pesticide formulators use both water-based and solvent-based formulations.

Only one of the six facilities prepared dry-based formulations. Dry ingredients are fed through a hopper opening for blending within horizontal

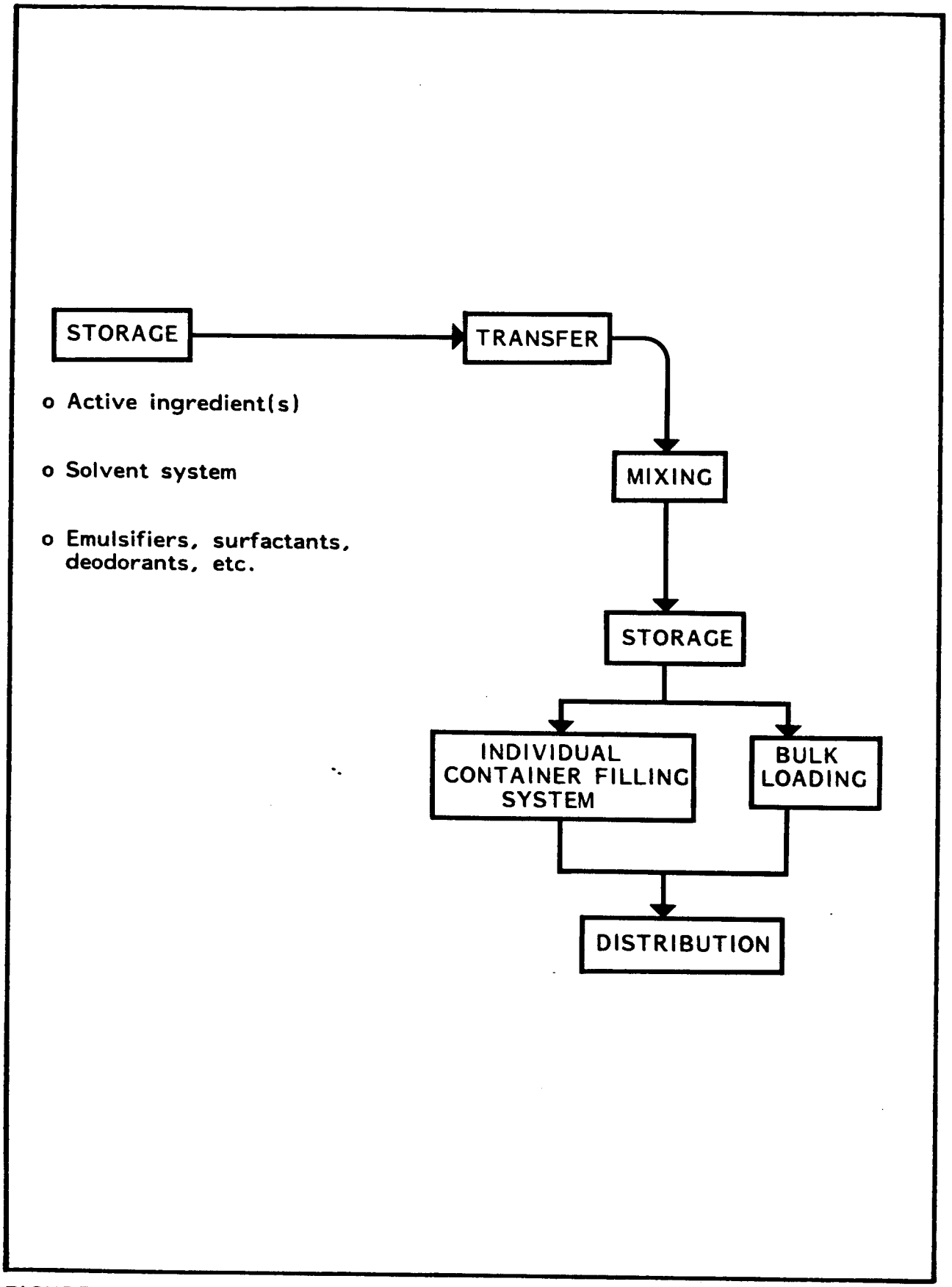


FIGURE 3.1: PESTICIDE FORMULATION PROCESS FLOW DIAGRAM

mixers. The system has provision for transforming liquid pesticides to wettable powders by spraying the liquid pesticides onto solid materials. When mixing is complete, the dry product is transferred to a feed hopper for subsequent filling of product containers.

3.3 Facility design

In 1977, the U.S. Department of Health, Education and Welfare published a Health and Safety Guide for Pesticide Formulators (16). This document provides guidelines for the design and operation of pesticide formulation facilities consistent with worker and environmental protection. In 1984, the Environmental Protection Service (Pacific and Yukon Region) provided general guidelines for the handling of chlorophenate solutions (18). Safeguards at pesticide formulation facilities visited for the purpose of this study are assessed on the basis of recommendations provided in the two above mentioned reports.

3.3.1 STORAGE OF ACTIVE INGREDIENTS

At five of the six pesticide formulating facilities, active ingredients were stored indoors and retained within their original containers until the actual formulation occurred. The active ingredients at the five facilities were either in liquid or flaked form. At the other facility, 1000 to 2000 pound blocks of active ingredient were stored on a concrete pad near the mixing tank. It was a general policy of this facility to receive the blocks from the manufacturer on an as-needed basis, and frequently formulation would be initiated within 24 hours of block delivery.

Storage area structures. Of the five facilities which stored active ingredients indoors, all storage areas were located within warehouses which had concrete floors and, metal or concrete block walls and metal roofs. At four of the facilities, the storage areas were adjacent to the formulation areas which were of similar construction. The fifth facility transferred working quantities of active ingredient to a formulation building which was of wood construction.

Spill control. At all but one facility, no active ingredients were received in bulk, and the largest containers of ingredients were generally 45 gallon drums or 50 pound bags. The exception was the facility which received 1000 to 2000 pound solid blocks. Total quantities of various active ingredients in storage vary considerably within a facility, and in the case of agricultural pesticide

formulators the quantities in storage are generally highest during spring and early summer. Due to the limited quantities of active ingredients in individual containers, the industry does not consider it necessary to berm storage areas. All storage areas were equipped with dead sumps to accommodate small spills. The areas of all storage facilities were such that the probability of escape of ingredients from a 45-gallon drum to the environment would be minimal.

Storage practices and labelling. All storage facilities attempt to assure that incompatible materials are not stored in close proximity. One of the facilities distributes chemicals for food processing, and such chemicals are completely segregated from industrial chemicals and pesticides.

All containers of active ingredients retain the labels originally provided by the manufacturers. In some cases, especially with 45 gallon drum containers, visibility of the labels was difficult. Overall signing (posting) to identify the presence of pesticides or toxic substances was minimal in storage areas. However, the facilities are clearly recognized as formulators of pesticides and the industry assumes that workers are aware of the need for care within the facilities. The extent of worker awareness was not evaluated.

One facility developed its own "worker friendly" labelling system to readily indicate the types of precautions necessary for handling of the many chemicals stored at the site. The labels indicated such properties as toxicity, flammability, and compatibility with other materials.

Solvents in storage include aqueous solutions (for example caustic soda) and organic solvents such as xylene, base oil, and methanol. With one exception, solvent and solution tanks were observed to be above ground and near the mixing areas. At one facility, below ground storage of organic solvents is used.

Fire protection. As noted previously, storage areas of all formulators visited during this study were constructed of non-flammable materials. Three of the six formulation facilities regularly use organic solvents in their

formulations (another facility adds methanol to its chlorophenate formulations during fall and winter months). Two of the facilities use bulk drums of flammable solvents, and the drums are grounded and bonded during the transfer process. The third facility transfers its solvent from a below ground system.

One of the formulation facilities is also a major distributor of chemicals and handles and distributes considerable quantities of flammable solvents. Transfer precautions such as bonding, truck braking, fire contingency, and equipment compatibility are strictly adhered to. Such practices indicate the active role which some companies have taken and the active role that fire departments have had in encouraging preventative measures.

All storage areas were reportedly visited by local fire departments to review precautionary measures and to familiarize fire fighters with facility layouts in case a fire did occur.

3.3.2 BLENDING OF INGREDIENTS (FORMULATION)

Transfer of active ingredients. Formulation facilities in British Columbia are designed for direct manual addition of active ingredients to mixing tanks. Granular solid active ingredients are received by the formulators in bags, and such bags are cut and simply emptied into the mixing vessels during the formulation process. When smaller portions are required, the ingredients are weighed on an open container placed on a scale and subsequently placed into the mixing vessel. At the one facility which utilized 1000 to 2000 pound blocks of active ingredient, the blocks were winch mounted and hoisted by winch to the top of the mixing tank. Subsequently the blocks were lowered into shafts within the mixing tank.

Liquid ingredients are added to mixing tanks either by simply pouring the contents of smaller containers of active ingredient or pumping quantities from 45 gallon tanks, into the mixing tanks.

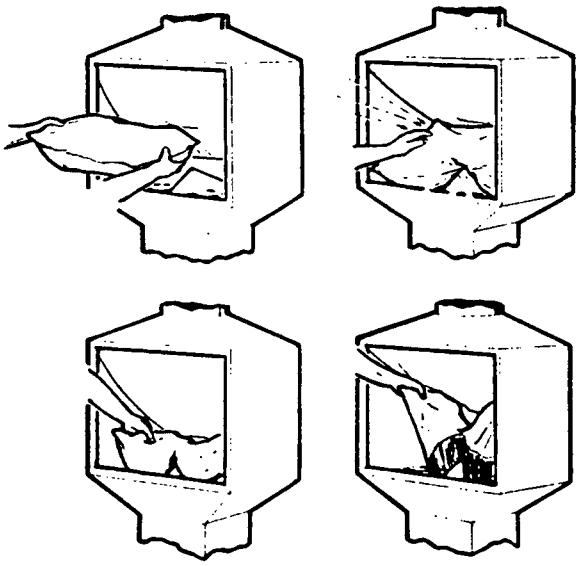
Ventilation. Two of the six facilities formulate their products under open-air conditions. The remaining four facilities provide systems for local exhaust ventilation of the process area. Two of these facilities use ventilation hoods

which exhaust air to the atmosphere via dust collection systems. The ventilation systems were not observed in operation during formulation activities and the systems have not been assessed for effectiveness. At one of the facilities, dust was observed throughout the work area, and it could be assumed that ventilation precautions were not adequate at this location. Handling and disposal of collected solids is discussed in Section 3.4.1.

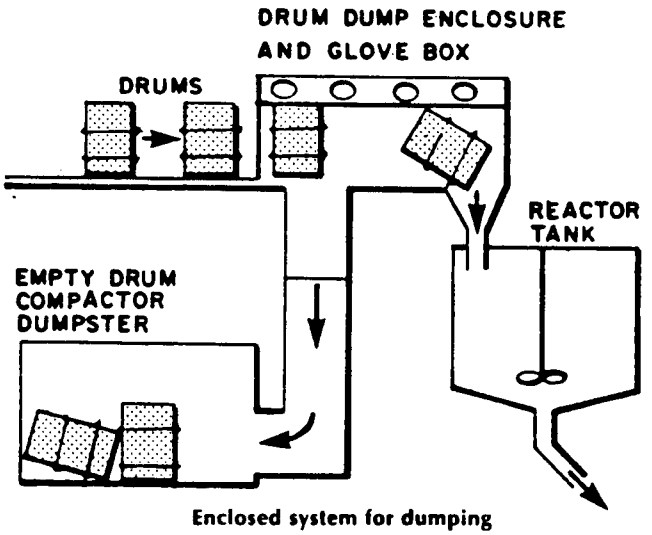
None of the facilities visited used ventilation design features recommended by NIOSH (1977). Examples are shown in Figure 3.2 and include the use of flexible covers on hoppers and enclosed systems for dumping materials from containers.

Mixing tanks. At five of six formulation facilities, liquid mix tanks were permanent upright steel tanks of volumes from 8,000 to 75,000 litres. Ingredients within the mixing tanks are agitated by means of top mounted impellers. At one facility, 1000 to 2000 pound blocks are added by means of a crane system to an outside mixing tank. Operator access to the top of the tank occurs via catwalk ladders. This mixing tank contains steam coils to enhance dissolution of the active ingredient by increasing the temperature to 50-60 degrees C. The mixing time at this facility continues until the active ingredient is completely dissolved (as long as six days). At four facilities, the mixing tanks are upright, inside, and two floor levels in height. The ingredients are added at the upper level and the products are transferred by gravity at the lower level.
The sixth facility uses a horizontally mounted 250 gallon drum which is secured by a wooden frame. This drum is located within a roofed but unenclosed area. The system is unsophisticated, consisting only of a top hatch for addition of ingredients, a side mounted motor driven agitator to effect mixing, and a spout system at the bottom for product removal.

Spill control. The largest mix tank (75,000 litres) is located outside and adjacent to an environmentally sensitive stream. This mix tank is bermed with concrete walls of size to contain approximately 40% of the entire contents of the mix tank.



Flexible cover on hopper reduces dust emissions



Enclosed system for dumping material in drums

FIGURE 3.2 VENTILATION DESIGN FEATURES RECOMMENDED BY NIOSH (16)

At four of the other five facilities, spills would be contained within building walls and dead sumps located within the floor containment systems. Due to the size of some of the facilities within which mixing areas are located, intensive interior cleanup efforts would be required. At some facilities a spill could result in contamination of material stored in adjacent rooms.

The fifth facility required sand bagging of an open doorway to assure that a spill would not reach an adjacent storm sump. None of the mix tanks at any of the five facilities contained individual containment systems. It is probable that at some of the facilities, a major spill from a mix tank would result in a limited release of tank contents to the outside environment. The releases probably would not be significant.

Fire precautions. Fire precautions in the mixing areas were of similar calibre to those described previously for chemical storage areas. One facility which regularly uses organic solvents has provided an explosion proof lighting system for the mixing area.

All but one of the mixing areas were located within concrete-floored, metal or concrete-walled, and metal-roofed structures. The exception was a facility which was located within an all wood structure.

Housekeeping. Housekeeping routines were defined for each facility to assure minimal dispersal of active ingredients from facility sites.

Labelling and signing. Active ingredients are kept within their original containers until transfer to the mixing tanks occurs. Manufacturers' labels are retained at all times. At two facilities, formulation personnel are given work orders which contain manufacturing instructions and safety precautions required for the handling of each ingredient. Workers are required to initial the work orders upon completion of each particular stage of operation.

Signs indicating "NO SMOKING" were used in mixing areas of all indoor facilities. "POISON" signs were not frequently used, probably because the work force understood that toxic chemicals were being handled at the facility.

Health protection. All facilities provided protective gear such as pesticide respirators, face shields or goggles , and rubber gloves for personnel involved with the formulation process. The formulation process was observed at only one of six facilities, and assessment of actual worker protection measures at other facilities was not possible. At the facility where the investigators were allowed to observe the process the workers constantly wore cartridge respirators, rubber gloves, and disposable coveralls. A high degree of precaution was observed throughout the process.

Maintenance of safety equipment was observed to be variable. Some facilities required operators to properly clean (or dispose) of safety equipment immediately after use. At other facilities, respirators were noted to be stored on top of, for example, solvent drums, and cleanliness for subsequent use was questionable.

All facilities had eye wash and showers in vicinity of the mixing areas. However the shower at one of the outside process areas was likewise located outside, and operators expressed possible hesitation in using the emergency shower on cold days.

Separate lunch rooms were provided at each facility. The lunch room of one facility was also used for storage of air masks.

Formulation personnel at most sites were generally encouraged to properly wash before leaving the premises. One company provided extra time for such procedures.

3.3.3 STORAGE AND SHIPMENT OF FORMULATED PRODUCT

Storage facilities. Products which are formulated for the wood protection industry are delivered to the end-user in bulk quantities. The shipments are

delivered by bulk-tank trucks with capacity up to 6000 gallons or by use of 1000 gallon fibreglas totes.

The one formulator which uses outside facilities has the largest storage tank of any facility for formulated product. The 20,000 gallon tank is bermed by concrete walls and situated on a concrete floor. This particular tank is located near an environmentally sensitive stream and berming is absolutely essential.

Two pesticide formulators for the wood treating industry store their formulated products in fibreglass tanks or totes which are located within their process buildings. The totes are shipped to the end-user. The totes and fiberglass tanks are not located within bermed areas.

Household and agricultural pesticide formulators do not store their formulated products in bulk as do wood treatment chemical formulators. After their formulation, household and agricultural pesticides are generally placed into retail sized containers directly from the formulation tanks. Holding or "nurse tanks" may be used to store formulated products until container filling is complete.

Transfer of formulated product for shipment. Transfer of formulations for bulk-truck shipment occur by pumping liquid from storage or mix tanks using flexible hoses. Only one of three facilities which undertake such transfers provide bermed pads to confine spills from the transfer process. Such precautionary measures were not present at the facility which is located adjacent to an environmentally sensitive stream. At another facility, confinement could be readily achieved, however a storm water drainage collection system is located within the unloading area.

Liquid formulations of household and agricultural pesticides are drawn from the mix or storage tanks by means of manually filling retail sized containers. The containers are then placed in boxes and stored in warehouse areas on pallets for subsequent shipment.

Solid formulations are placed in feed hoppers of fillers. Subsequently the product is discharged through a filler pipe to product containers which are placed and capped manually. Solid formulations are handled at only one site in British Columbia, and this facility utilizes a powerful suction system near the mouth of the product containers to minimize releases to the workplace. Despite this, large amounts of dust were observed on the floor of the workplace.

Workplace precautions. Comments provided previously on workplace precautions at formulation areas (Section 3.3.2) are applicable to precautions in storage areas. Bulk loading procedures (i.e. wood treatment chemicals) are well defined and all facilities used only one or two individuals continually for the loading, transport and unloading of products. These individuals were therefore familiar with precautionary procedures. In fact, all individuals responsible for transport to end-users were encouraged to relate any concerns regarding handling practices by end-users.

Actual workplace precautions at the sites of the two household and agricultural pesticide formulators were not observed (one facility was not formulating at the time of the study, and at the other facility, the study team was not allowed to observe workplace procedures). Nonetheless, it is the judgement of the study team that the equipment of one facility was such that there was sufficient potential for worker exposure during manual filling of retail sized containers. At the other facility, there appeared to be potential concern for worker exposure during the filling of containers with solid formulations.

3.4 Process emissions

3.4.1 SOURCES, CHARACTERIZATION AND DISPOSAL

The pesticide formulation process consists of simply blending various ingredients within a closed system and packaging the blended mixture. Ideally the process could be achieved with the absence of any environmental or workplace emissions. In reality, there are several sources of environmental and workplace emissions within the British Columbia pesticide formulation industry as shown in Figure 3.3.

SOLID WASTES

Solid wastes are the major form of emissions from facilities visited during this study. The solid wastes consist of: bags and wrappings used to contain active ingredients; drums used to contain liquid ingredients and solvents; solids from dust collection systems; and, filtered materials. The predominant method of disposal of bags and wrappings is municipal landfill disposal via companies such as Smithrite. Two facilities used drums or containers of liquid active ingredients, additives and solvents. One facility gave its drums to a drum reclaimer. The other facility generally used smaller containers (eg. 1 gallon) and these containers were rinsed and disposed in either a secure landfill or municipal landfill, dependent upon the original content of the containers.

The solid wastes with the highest concentrations of active ingredients are probably the solids obtained from dust collection systems. Only two of six formulation facilities use air dust collection systems. The other four formulation facilities either formulate in outside facilities or use only liquid ingredients. Of those which formulate outside, the ingredients or scale of operation are such that dust collection systems would not be of much use.

Of the two facilities which use air dust collection systems, one facility uses the system to provide proper dust control during unloading of solid ingredients and for general ventilation of the workplace. The other facility uses its air dust collection system for various purposes including general

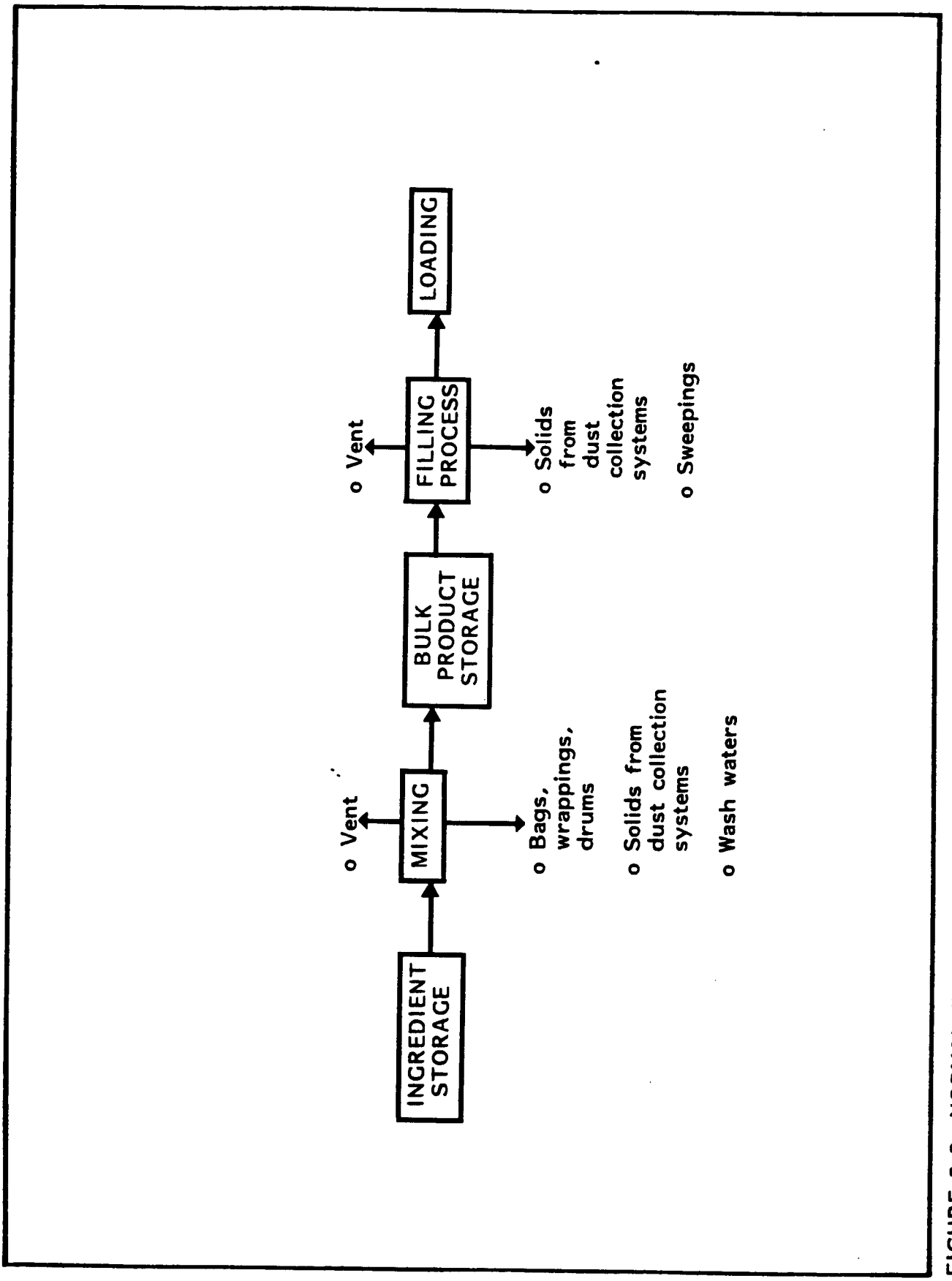


FIGURE 3.3 NORMAL EMISSIONS DURING PESTICIDE FORMULATION

ventilation of the workplace, dust control during unloading of solid ingredients, dust control during filling of containers with formulated solid products, and vacuuming of dust from equipment and floors. The latter facility accumulates between 40-60 drums of solids per year, and the drums are disposed of at a secure landfill site in the U.S. The former site likewise disposes of its solids at a landfill in the U.S.

Only one facility filters its formulated product. This facility used a sock filter which is reportedly disposed along with dust control system solids in a secure landfill site. Another facility formerly filtered its formulation, however only coarse screening is now used. When filtration was used, the filtered material was disposed in a municipal landfill.

Floor sweepings were said to be contained at all facilities. One chlorophenate formulation facility claimed to recover chlorophenols from dust by dissolution in caustic solution.

AIR EMISSIONS

As mentioned previously, two of six facilities had used dust collection systems for control of air emissions within and from the workplace sites. No assessments of the effectiveness of the dust collection systems have occurred and only one of the two facilities had a municipal air discharge permit.

LIQUID EMISSIONS

Under normal circumstances formulation facilities should not have liquid emissions which contain pesticides. A U.S. Environmental Protection Agency review of the United States pesticide formulation industry identified several wastewater sources from formulation facilities:

- Equipment cleanup waters (usually the largest source of wastewaters at formulation facilities). Frequently wastewaters were reused in subsequent batches.
- Drum washings.

- o Housekeeping washdown waters. Most facilities are swept and vacuumed before washdown.
- o Spills. Most spills were kept within work areas and absorbed on sand or clay.
- o Air pollution water-scrubbing devices.

Three of the six formulation facilities visited during this study prepared only one product or products with only one active ingredient. Such facilities therefore do not require washing of mix tanks, or if washing does occur, the wash waters are reused in subsequent batches. Three facilities prepared a variety of formulations and they attempted to reuse washwaters to the greatest degree possible. If reuse is not possible, the washwaters are said to be stored and shipped to the U.S. for secure landfill disposal.

Disposal of reject batches is reportedly not required by B.C. formulators. Off-spec batches are adjusted to acceptable limits by dilution or addition of active ingredient(s).

Other sources such as drum washings and housekeeping washdown are generally minimal. Drum washing were said to be added to formulations. At the time of this study, no B.C. formulation facility used air pollution water-scrubbing devices.

Two formulation facilities do have wastewater treatment systems which are used for treatment of liquids generated within other processes. One of the facilities uses an outside lagoon to treat: wastes from various processes (e.g. urea-formaldehyde, phenol-formaldehyde, polyvinyl acetate resin production); vacuum pump water; transport tank wash water; and, runoff waters from the site. The treated wastewaters are not known to have been analysed for the pesticide used at this facility. The other facility collects high pH waters from detergent formulations as well as floor wash waters and drippage. The system is used only for pH control and analyses for pesticide active ingredients within the effluent have not been carried out.

3.4.2 Historical Releases

Historically, three incidents of environmental releases of pesticides from British Columbia pesticide formulation facilities are known by regulatory agencies. The sources and types of releases are summarized in Figure 3.4 and described below. Such releases would not be expected from properly designed and operated facilities.

In 1972, regulatory agencies detected organophosphate and organochlorine pesticides in wastewater effluents and runoff waters from a pesticide formulation facility. Soils from the yard were also found to contain large quantities of pesticides. Chemical mixing was performed outside and, spillage and dispersal of active ingredients was assumed to be the main cause of environmental contamination. Other sources included leaking waste drums and air emissions from the entire facility. The site was subjected to considerable study and deliberation. Development of the site is now restricted and encapsulation of the site is required for at least 20 years.

In 1984, a spill of 10,000 gallons of tetrachlorophenol solution from storage tanks of a formulation facility resulted in considerable fish kills within an adjacent stream. This particular facility does not normally handle chlorophenols and the solution was on-site for removal of waxes which had been previously added. Vandalism was said to be the cause of release of the solution. The storage tanks were not bermed and the valves had no safety precautions to prevent inadvertent releases. The company was charged under Section 33(2) of the Fisheries Act. Total cleanup costs were in excess of $250,000. As a a result of the incident, the facility was also cited by the Workers' Compensation Board for inadequately labelled tanks and absence of emergency spill procedures.

A minor release of chlorophenate occurred at another formulation facility due to an overflow from the mixing area. The liquid reached a drainage sump and subsequently flowed towards a drainage ditch adjacent to the property. The company reported that it had contained the spill at the ditch. Further information on the effectiveness of the control effort was not available.

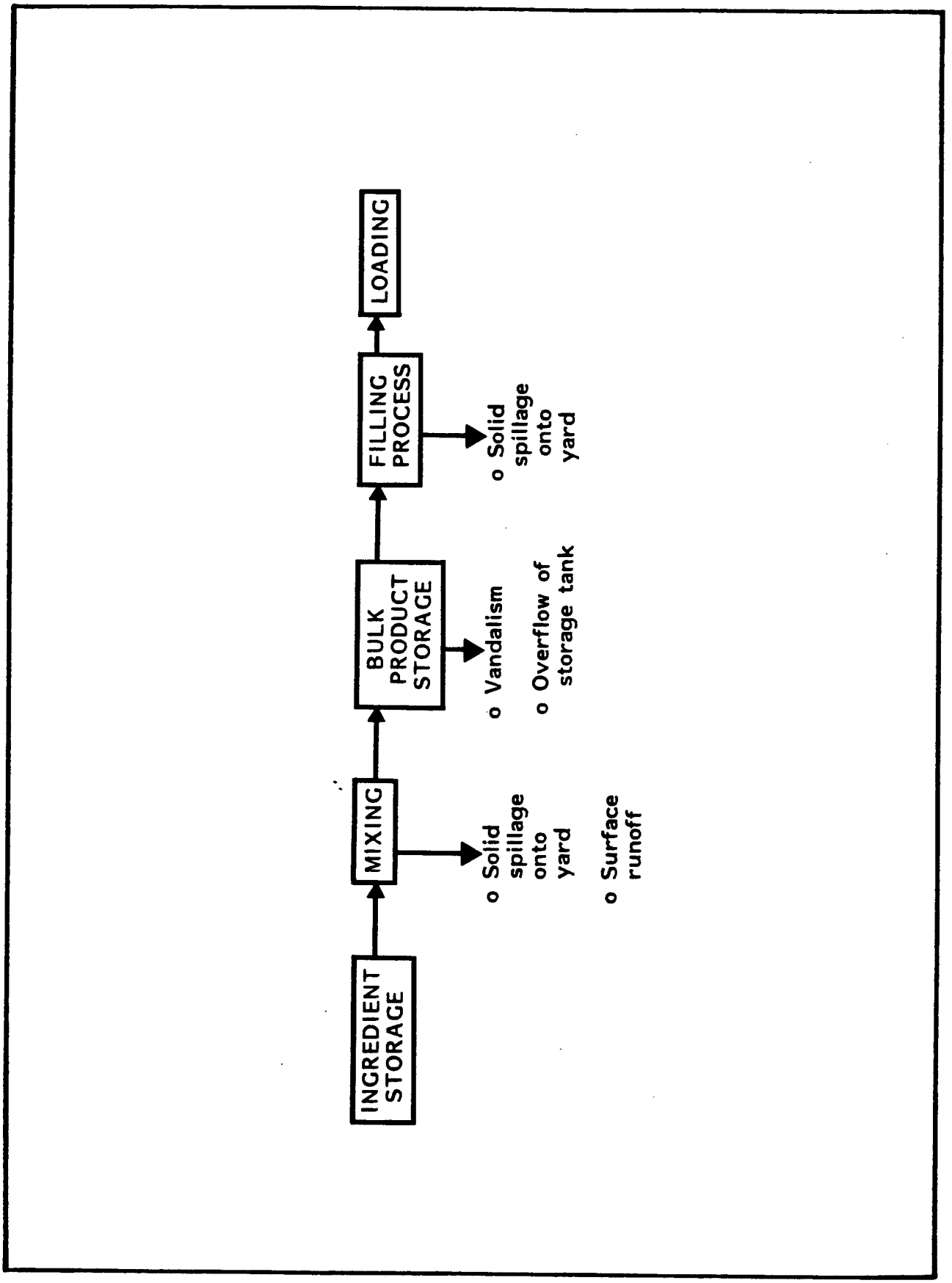


FIGURE 3.4 HISTORICAL RELEASE SOURCES FROM BRITISH COLUMBIA PESTICIDE FORMULATION FACILITIES

3.4.3 ENVIRONMENTAL MONITORING

Routine monitoring of emissions from pesticide formulation facilities in British Columbia has been minimal. It is generally assumed by regulatory agencies and the industry that "closed-processes" are used.

Air sampling has been restricted to monitoring of workplace concentrations for the benefit of worker protection. Outside air sampling, including assessment of the effectiveness of dust collection systems , has not been undertaken.

There have been no assessments of yard surface runoff waters in vicinity of existing facilities. As noted previously, two facilities with wastewater treatment plants do not analyse for pesticides in effluents, although the probability of the presence of pesticides in effluents was said to be minimal. One municipality reported that sewer line samples in the vicinity of formulators (located within a municipality) were taken and analyzed to determine whether industrial discharges were occurring.

The only monitoring in vicinity of any formulation facility appears to have been at a site described in Section 3.4.2. The site was previously occupied by Laters Chemicals Limited. Samples of ditch waters and yard runoff waters showed the presence of diazinon, chlordane, DDT, malathion, ethion, 2,4-D, 2,4,5-T, and methoxychlor. Bioassays with ditch water samples showed that 100% of test fish died within 6 hours of exposure to undiluted samples. Surface samples of yard soils showed total DDT concentrations of 3,200 ppm in vicinity of the formulating plant and 6,544 ppm in vicinity of the warehouse/baghouse facility. Another soil sample obtained in the vicinity of the formulating facility showed an arsenic concentration of 275 ppm. Borehole samples were also analysed and pesticide concentrations in excess of 1 ppm were found at depths to 20 feet. Soils from the perimeter drainage ditch had total DDT concentrations of 2,840 ppm. Monitoring for the benefit of problem identification and assessment of cleanup requirements occurred over a period from 1972 to 1980. Following a partial cleanup of the site, a limestone cap was installed over the yard surface to minimize infiltration of precipitation to contaminated subsurface soils. Furthermore, a sediment trap was installed

to control release of runoff associated particulate matter from the site. Monitoring of surface runoff waters still occurs with review of data by the municipality and the Environmental Protection Service.

A spill of tetrachlorophenol from storage tanks occurred from the site of Cloverdale Paint and Chemicals Ltd. which is located in Surrey, B.C. Extensive analyses were used to assess the extent of chemical dispersal on the yard and in the environment. In addition biological assessments of fish and benthic organisms were used to evaluate the degree of biological impact and subsequent recovery.

3.4.4 OCCUPATIONAL HEALTH MONITORING

There has been a recent trend in improving work place conditions in order to minimize worker exposure to chemicals in use at pesticide formulating facilities. The improvements have been instigated upon initiatives and suggestions of management, worker unions, and agencies such as the Workers' Compensation Board. Practices deemed "acceptable" 10 years ago, are in many instances considered to be "inadequate" by today's standards.

Of the six formulation facilities visited, two had regular biomonitoring programs. Both companies were affiliates of large firms with headquarters in the United States. The occupational health programs were defined and overseen by industrial hygienists from headquarters offices. At one facility, cholinesterase levels in blood samples from workers are evaluated monthly, and the data were forwarded to the Workers Compensation Board. The other facility hires a local industrial health hygiene specialist to provide a complete physical check (including blood and urine samples) every two years. The facility also monitors workplace air quality at least once per month. The data of the health studies and air quality analyses are forwarded to the company's headquarters for review.

Work safety educational programs were said by management to be in place at all six formulation facilities. Four of the six facilities had workers manuals

which described the necessary precautions associated with the chemicals in use. Two of the other facilities had such manuals under preparation. Programs to familiarize workers with the contents of such manuals were variable. At least three of the six formulators had regular safety meetings to ensure understanding of the contents of the safety manuals and to discuss design and operational improvements.

Provincial and federal health agency personnel note a large improvement in safety measures within the pesticide industry during the past several years. Some concerns of health agency personnel still remain (at some but not all facilities), and the areas of concern include:

- o Identification of chemical containers. Chemicals (e.g. active ingredients and formulations)and their hazards are generally not well known to all workers in a facility or to transporters of the chemicals.
- o Availability of information on chemicals in use.
- o Absence of spill control and contingency programs.
- o Worker education programs.
- o Selection and presence of proper protective equipment. (e.g. air masks)
- o Transfer of low flashpoint liquids without grounding of vessels.
- o Adequacy of workplace ventilation.
- o Equipment safety. Guarding of rotating shafts, adequacy of loading capacity of forklifts, etc.
- o Storage of incompatible materials.
- o Housekeeping practices. Frequently, spills and dusts are not cleaned up immediately.
- o Handling of talc fillers. Some fillers which were claimed to be asbestos free, were found to contain asbestos.
- o Transportation. Subcontractors responsible for transportation may have minimal knowledge for handling of toxic chemicals.

3.5 Summary of regulatory involvement

3.5.1 FEDERAL GOVERNMENT

With regard to the evaluation of environmental and occupational health aspects associated with the B.C. pesticide formulation industry, two Federal agencies have had direct active involvement: Agriculture Canada and the Environmental Protection Service of Environment Canada.

Agriculture Canada

Agriculture Canada is the responsible agency for the Pest Control Products Act which is the most important Federal Statute regulating pesticides in Canada. The main intent of the Act is to ensure that pest control products meet prescribed standards. The Act states that every pesticide must be registered by Agriculture Canada before it can be sold in Canada. Before registration is granted, the manufacturer must provide scientific proof that the pesticide is effective for the claims made on the label and that it is safe when used as directed. Section 3(1) of the Act makes it an offence to manufacture, store, display, distribute or use any control product under unsafe conditions.

In 1984, Agriculture Canada had 1.1 man-years allocated to administer the Act in British Columbia. Additional manpower allocations were anticipated during the near future. As a result of the limited resources, the activities of the local Agriculture Canada representatives were mainly restricted to sampling formulated products (quality control assurance and consumer protection) and to providing information to the public and other government agencies such as Customs and Excise. With regard to liaison with Revenue Canada (Customs and Excise), one Agriculture Canada representative indicated that control of pesticide imports is extremely difficult due to inability of Customs and Excise to have an on-site expert on pesticides. Customs officers must deal with a wide range of products and the inability to rapidly verify declared products results in the use of minor quantities of unregistered pesticides within the Province.

Environment Canada

The Environmental Protection Service of Environment Canada has interacted with the British Columbia pesticide industry on the basis of Environment Canada's responsibilities for the Fisheries Act and the Environmental Contaminants Act. The interactions with the industry have occurred during:

- o Its lead role as Federal representative in working with Provincial agencies in assessing and defining clean-up measures at the Later Chemicals Ltd. and Cloverdale Paint and Chemicals Ltd. situations described above. The activities were under the auspices of the Fisheries Act.
- o Its sponsorship of a technical recommendation document (18) for chlorophenate use in wood production industry.
- o Its 1984 survey with Agriculture Canada (under the authority of the Pest Control Products Act and the Environmental Contaminants Act) of sales of selected pesticide active ingredients in Canada.

3.5.2 PROVINCIAL GOVERNMENT

Pesticide Control Branch

The Pesticide Control Act of British Columbia is administered by the Pesticide Control Branch of the B.C. Ministry of Environment. The Regulations under the Act apply to the sale, distribution, application, transportation, storage, and disposal of pesticides. Most of the activities under the Act pertain to retailers and users. The two household and agricultural pesticide formulators noted in this report have been visited by a representative of the Branch in the context of the formulators' role as retail vendors to end-users. Therefore the Branch representative assures that personnel responsible for the sales are licensed vendors and assures proper storage of products available for sale to end-users. The Pesticide Control Branch was designated as the lead agency for the assessment and definition of cleanup measures at the former Later Chemical Ltd. facility.

Waste Management Branch

Environmental emissions are regulated by the Waste Management Branch of the B.C. Ministry of Environment. None of the formulation facilities had effluent, solid waste, or aerial emission permits from the Waste Management Branch, because the sites are all located within the Great Vancouver Regional District. Emissions, if any, are therefore regulated by the municipalities. The Branch was nonetheless familiar with all pesticide formulation sites. The Branch has also actively participated in assessment and cleanup of site contamination at the former Later Chemicals Ltd. site and at Cloverdale Paint and Chemicals Ltd.

A representative of the Waste Management Branch outlined some concerns about waste handling and storage practices at formulation facilities. The 1982 Waste Management Act provides the framework within which the Waste Management Branch would regulate such aspects as waste storage, disposal and transport, and spill prevention. As of March, 1985 no regulations have been formalized under the Act, and the Branch has a limited mandate for enforcing good waste handling practices.

Workers' Compensation Board

Under the authority of the Workers' Compensation Act, the Workers' Compensation Board has prepared "Industrial Health and Safety Regulations". The regulations intend to improve industrial health and safety in the workplace, and are written to be applicable to all industries. The regulations include identification of permissible concentrations for airborne contaminant substances including specific pesticides.

The Board has inspectors who assess whether industries are in compliance with the above noted regulations. Manpower for industrial hygiene assessment is limited, and the priorities of the Industrial Hygiene section are to investigate situations where: labor stoppage has occurred; claims are placed; and, histories of problems exist. Routine evaluations are next in priority. During a routine evaluation, the Industrial Hygiene inspector must actually

observe practices of concern, and may not speculate on problems which could occur with equipment which is not in use during the inspection. Occasional air sampling studies are carried out by the Board to assess whether ambient chemical concentrations are in excess of values specified within the Regulations. If values are found to be less than the specified upper limit values, then these values are not recorded. Despite the limitations on manpower for industrial hygiene assessment, personnel from the Workers' Compensation Board had an extensive data base on working conditions within B.C. pesticide formulation facilities.

3.5.3 MUNICIPALITIES

Municipalities may take active roles in the control of design and even operational practices at facilities such as pesticide formulators. For example, the municipality of Richmond requests "environmental protection information" from companies applying for building permits, business licences and development permits. The municipality requests information on industrial processes, chemicals in use, intended protection measures for water and soil, emissions, and anticipated noise levels. Furthermore, the municipality has an environmental protection policy for chemical storage and on-site handling . The policy deals with contingency planning, retaining wall requirements, underground storage, storage of sealed containers, and vacating of sites.

Most municipalities in the province, have designated "emergency coordinators" who are responsible for dealing with chemical spills. The coordinators would work with the municipal fire departments, health, environment, and public works departments, in defining contingency procedures and subsequent clean-up measures. The coordinators would likewise liaise with the Provincial Emergency Program.

Municipal firefighting departments have played active assessment roles at each formulation facility visited. The intent of the departments is to play a preventative role to minimize the probability of fires at such facilities and to become familiar with facilities in case problems will occur.

In one particular case, a municipality became involved in the assessment of environmental impacts of pesticide formulation facilities. The Richmond Health Department has been and still remains active in the assessment of runoff water quality from the former Later Chemical Ltd. site. The Department also provided an assessment on behalf of the municipality, with regard to future site use. Although the Health Department has a minor role in enforcement, it has a mandate of "general public health protection" within the Municipality. The Department is viewed within the Municipality as "closest to the public" and serves as the Municipal council's advisor on local health and environmental issues.

3.6 Environmental risk assessment

In principle, pesticide formulation facilities should have minimal or no normal environmental emissions. However emissions were observed in this study and in the previously cited study of the U.S. Environmental Protection Agency (16).

Solid wastes were the major components of the emissions which were observed during this study. The solid wastes consisted of: contaminated plastic wrappings, bags or containers previously used for delivery of ingredients; solids from the dust collection systems; and, floor sweepings.

Two of six facilities had dust collection systems and the dusts were stored in drums and disposed at EPA-approved secure landfill sites in the US. Floor sweepings at all facilities were said to be either reused in the formulation process or stored and subsequently disposed of at secure landfill site. Of concern, was the disposal of contaminated plastic wrappings and bags in municipal landfills. This practice is contrary to good waste management as defined by even the industry's own Technical Committee of the Canadian Agricultural Chemicals Association. Also of concern was the shipment of empty containers to drum recyclers. The reuse of such drums is not monitored or controlled.

Air emissions to the outside environment have not been assessed, although it is believed that the emissions are minimal and restricted to the immediate vicinity of formulation facilities. Concentrations of active ingredients within the workplace have been assessed at most facilities, and due to the more intensive control efforts in the past several years, the concentrations have generally been within acceptable ranges.

There are few sources of wastewaters within pesticide formulation facilities. The most probable contaminated waters from pesticide formulation facilities would be surface runoff waters which have been exposed to loading and storage areas. Surface runoff water quality in vicinity of any existing formulation facilities has not been assessed. Most facilities have a high degree of

chemical control during their formulation processes, and it is anticipated that runoff waters at most facilities would contain minimal concentrations of active ingredients.

In summary the existing pesticide formulation facilities within British Columbia should not pose a risk to the environment under normal operating conditions. However, improvement in solid waste control practices is recommended.

There is, however, a potential for abnormal releases from formulation facilities and the subsequent environmental impacts can be substantial. The environmental impacts from two such releases have been briefly described earlier in this report. Generally speaking, the releases occurred because of:

- o the absence of containment,
- o lack of security precautions,
- o inadequate maintenance, operating and housekeeping procedures,
- o lack of defined contingency measures, and/or,
- o improper on-site disposal of liquid and solid wastes.

The above disparities still can be identified at some of the formulation facilities visited during this study. However, environmental impacts to the degree noted previously would probably not occur.

3.7 Human health risk assessment

Pest control products are potentially dangerous chemicals which should present little or no hazard to workers if appropriate protective measures are observed during formulation, transportation, or end-use. No health effects on British Columbia formulators were reported to the study team by either the industry or the Workers' Compensation Board (other than skin rashes noted in one instance).

In the past few years the pesticide formulation industry has made extensive improvements in human health protection. At some facilities, improvements could still be made to alleviate concerns such as those expressed in Section 3.4.4. Considering those concerns and observations of the study team, several improvements are especially highlighted:

- Worker education is highly variable at facilities, and training employees on handling and disposal practices, personal hygiene, and emergency procedures is essential at all facilities. The NIOSH Health and Safety Guide for Pesticide Formulators (16) should be mandatory reading for all plant personnel.
- Labelling of containers, tanks and process lines is highly variable at facilities, and should be reviewed at some facilities.
- Local exhaust and ventilation systems, and enclosed operations should be used to a greater degree to minimize worker exposure to air emissions created during the formulation process.
- Assurance should be made that all transporters of formulated product are aware of handling precautions and contingency measures associated with each product.

4 PESTICIDE DISTRIBUTION IN B.C.

4.1 Overview of facilities

As noted in Section 2.2, there is not a consistent delineation between the role of formulators, distributors and retailers within the B.C. pesticide industry. In fact a particular company may perform all three roles, and categorization as either formulator, distributor or retailer may be misleading. For the purposes of this study, a distribution facility is considered to serve as a focal storage point of formulated products from which the products are distributed to retailers within a regional area.

The apparent major distributors and storage areas for agricultural and household pesticides in British Columbia were previously identified in Figure 2.4. All British Columbia formulators of wood treatment chemicals distribute their own products. In addition, one formulator of agricultural and household pesticides (Van Waters and Rogers) acts as a distributor of wood treatment chlorophenates which are formulated in the state of Washington.

To complement the overview of the pesticide formulation industry, it was the intent of this study to provide a general perception of practices associated with the storage and distribution of pesticides. As a result, three facilities were visited and various personnel from industry and government were contacted to provide a general assessment. All major identified distribution and storage facilities noted in Figure 2.4 would require additional assessment.

4.2 Facility descriptions

4.2.1 HOUSEHOLD AND AGRICULTURAL PESTICIDE DISTRIBUTORS

Three household and agricultural pesticide product distribution sites were visited. The sites were among the largest pesticide distribution facilities in the Province.

At all sites, pesticides were stored indoors within concrete-floored, metal or concrete sided, and metal roofed structures. The structures were generally of large area and with high roofs to facilitate ventilation. Individual containers and palleted boxes of prepackaged formulations were stored on metal shelves. If materials other than pesticides were handled at any facility, pesticide storage was separate from the storage areas for other materials. Large distributors may also have storage areas to separate insecticides from herbicides.

Until recently, many large storage facilities installed automatic fire extinguisher sprinklers within areas used to store chemicals such as pesticides. Currently the industry and government regulatory agency personnel are of the view that sprinklers may result in greater problems due to the need for control of contaminanted waters if sprinklers are activated.

Two distributors stored both liquid and solid formulations in areas with temperature control. While one distributor assured that liquid formulations were always stored in heated areas, solid formulations may be stored in unheated areas at this site.

Quantities of pesticides in storage at all three facilities are seasonal, with the largest quantities in storage during early spring. At two of the facilities it is estimated that household and agricultural pesticides formulations in the order of "hundreds of tonnes" could be in storage and awaiting distribution.

Discussions with industry and government representatives indicate that not all pesticide storage and distribution facilities in the Province are constructed in a similar manner as described for the three visited facilities. In fact some industry representatives expressed concern about fire prevention, control of environmental releases, and joint storage with non-pesticide materials at some facilities.

Pesticide formulations are subsequently loaded for transportation onto truck lines which are either consigned by the distributor or by the end-user.

4.2.2 WOOD TREATING CHEMICAL DISTRIBUTORS

Two facilities store bulk quantities of formulated wood treating chemicals in outdoor tanks. At both facilities, the tanks are located on concrete paved areas which are surrounded by concrete berms. Bulk tank truck loading facilities are located in the vicinity of the storage areas. Although the loading areas are surfaced, they are not bermed to contain any accidental spillage.

Wood treatment chemicals are transported to the end-users by trucks which are either leased and/or owned by the formulators. Drivers of the vehicles are generally employees of the formulation company.

4.3 Emissions

Emissions from household and agricultural pesticide distribution and storage facilities would only occur upon accidental release such as puncturing of bags or dropping of containers. Within distribution facilities it is anticipated that the facility personnel would be able to contain such accidental releases. During transportation, the probability of releases of formulated pesticides to the environment increases due to handling by personnel less familiar with the products.

In the past few years there has been increased attention to the provision of guidelines by industry and government for the control of pesticide spills resulting from transportation and warehouse accidents. For example, the Canadian Agricultural Chemicals Association has recommended procedures for clean-up and disposal of pesticide spills. In addition the Association has recommended the presence at all times of basic equipment and material for clean-up of spilled pesticides (19).

In the case of wood treatment chemicals, emissions would likewise occur only during accidental releases. The potential for environmental impact of a wood treatment chemical spill is much more than for a household or agricultural pesticide spill because of the large bulk quantity of a wood treatment chemical which may be stored within a single tank. As mentioned previously, most facilities do not use bermed loading areas and the most probable time of release and environmental impact would be during the loading and unloading of the transport truck.

4.4 Regulatory involvement

Unless a distribution centre is involved in retail sales to the end-user, the operation may be overlooked by regulatory agencies in terms of environmental safety. As understood at the time of this study:

- o Agriculture Canada inspectors visit such sites to assess product quality (i.e. to assure concentrations of active ingredients are as labelled on the packages) and to assure labelling requirements are adhered to.
- o Pesticide Control Branch personnel visit sites which sell to end users to ensure that pesticides are sold by licensed personnel and to ensure proper storage of products.
- o Waste Management Branch personnel visit sites to determine if environmental emissions are possible.

4.5 Environmental and health risk assessment

The three sites visited during this study were "well-run" facilities. In general, it appears that there are many other similar facilities within the Province. Examples of exceptions to these facilities were described by regulatory and industry representatives. An accurate assessment of the environmental and health risk associated with British Columbia pesticide distribution facilities would require an evaluation of most of the 22 facilities identified in Table 2.6. Representatives of industry and government who are familiar with many of the B.C. distribution facilities have cited some of the follow up concerns which may exist at some facilities:

- o the lack of appropriate signing (posting) in some pesticide storage areas;
- o the storage of pesticides with goods which in some cases are not remotely affiliated with the chemical industry;
- o the storage of pesticides in flammable structures;
- o the lack of disposal facilities in the province for spilled chemicals such as pesticides;
- o the lack of regulatory agency assessment of many such facilities with regard to design and operation;
- o the possible lack of proper handling of pesticides during the transport to retailers.

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111 DISCOVERY PARK ☐ 3700 GILMORE WAY ☐ BURNABY, BRITISH COLUMBIA V5G 4M1 ☐ (604) 434-3656

31 March 1985

Mr. Douglas M. Wilson
Senior Program Officer
Environmental Protection Service, Pacific Region
Kapilano 100
Park Royal
West Vancouver, B.C.
V7T 1A2

Dear Doug:

RE: DSS CONTRACT NO 06SB.KE603-4-0375
Inventory and Characterization of Pesticide Formulators and Other Chemical Distributors in British Columbia

In partial fulfillment of the above-noted contract, we are pleased to submit this report of our site visit to Walker Brothers, Division of SCM (Canada) Ltd., Burnaby, B.C. This and the other site visits (summarized in separate reports) were undertaken on your behalf by the undersigned and we would be pleased to answer any additional questions about our visits or the comment and assessment provided in the reports.

We would like to acknowledge the cooperation and assistance of the site contacts (named in the reports) who showed us their facilities and provided candid answers to our questions. We stress that the information in these reports was provided voluntarily, but under our assurance that specific detail about facilities would remain confidential and be used for providing the needed background for the overview assessment report submitted in final fulfillment of this contract. We respectfully request that you carefully note this requirement for confidentiality when authorizing the distribution of the attached site visit report.

Finally, please note that the Summary Assessment (Section 9) of each site visit report provides our overall assessment of chemical management at the visited facilities (for specific chemicals of interest under the contract). The assessments (and occasional recommendations) are based solely on the the subjective opinions of the authors. However, we believe that the assessments are consistent with recognized good management practices for the chemical handling industry, and we offer recommendations for improvments which we believe serve the interests of both industry and the regulatory agencies by providing sound protection of workers and the environment.

Yours truly,

Dr. Frank A. Henning, P.Eng.

Dr. Dennis E. Konasewich

DESCRIPTION AND ASSESSMENT OF WALKER BROTHERS BURNABY, B.C.

ENVIROCHEM SERVICES

MARCH, 1985

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FIGURES AND TABLES

1.0 SITE IDENTITY

1.1 FACILITY NAME AND ADDRESS

Walker Brothers
Division of SCM (Canada) Limited
5684 Beresford Street
Burnaby, B.C.
V5J 1J2
(604) 434-1374

1.2 SITE CONTACTS

Maurice Walker, Plant Superintendent
Larry Wong, Laboratory Manager

1.3 INFORMATION SOURCES

Discussions with the above-noted contacts during site visits on 4 October and 19 November, 1984. Additional discussions with the following individuals on the noted dates:

23 October, 1984	A.Luck, Supervisor, Industrial Hygiene Inspections, B.C.WCB.
26 October, 1984	B. Vance, Regional Manager Pesticide Management, B.C.MOE Surrey
	R. Hawes, WMB, B.C. MOE (Surrey)

1.4 SUMMARY OF CURRENT OPERATIONS

Table 1 summarizes the status of operations and facilities for chlorophenate solution production at the site. Walker Brothers is a division of SCM (Canada) Limited which produces and distributes a wide range of paints, coatings and chemical products. The Burnaby plant employs 26 people (9 in the manufacturing plant) and operates

TABLE I: OPERATIONS SUMMARY (WOODSHEATH PRODUCTION)
WALKER BROTHERS BURNABY, B.C.

SITE DESCRIPTION			
SIZE	0.15 HECTARES	TOPOGRAPHY	GENTLE SLOPE TO THE SOUTH AND EAST
SETTING	GENERALLY INDUSTRIAL SURROUNDED BY COMMERCIAL AND RESIDENTIAL	DRAINAGE	TO THE FRASER RIVER VIA SURFACE DITCHES (SOUTH FROM THE SOUTHEAST CORNER OF THE SITE)
SURFACES	PAVED ACCESS LANES (THE BUILDING COVERS MOST OF THE SITE)	SURFACE WATERS	NONE ON SITE THE FRASER RIVER LIES 2 KM TO THE SOUTH
SOILS	NO INFORMATION	GROUNDWATER DEPTH	NO AVAILABLE INFORMATION

FACILITY DESCRIPTION			
BUILT	1948	EXPANSION STATUS	NONE PLANNED
USE AREA	SHELTER	FLOOR/GROUND SURFACE	CONTAINMENT
CHLOROPHENATE MIXING	INTERIOR (2 STORIES)	WOODEN FLOOR (UPPER) CONCRETE (LOWER)	NONE IMPROVISED (SANDBAGS)
CHLOROPHENOL STORAGE .SEPARATE WAREHOUSE .IN MIXING AREA (2ND LEVEL, AS ABOVE)	INTERIOR	CONCRETE	NONE
CHLOROPHENATE STORAGE	INTERIOR	CONCRETE (MAIN LEVEL)	AS MIXING AREA (ABOVE)
CHLOROPHENATE LOADING	EXTERIOR	PAVED (CONCRETE)	NONE

CHEMICALS (TETRACHLOROPHENOL)			
FORM	DELIVERY	STORAGE CAPACITY/MODE	ANNUAL USE (kg)
SOLID FLAKES (50 PD.BAGS)	TRUCK (INCOMING)	WAREHOUSE (SEE ABOVE)	81,300 KILOGRAMS (JULY '83-JUNE '84)

PROCESS WASTES/RELEASES			
FORM	POINT OF GENERATION	ANNUAL QUANTITY	DISPOSITION
LIQUIDS .TANK RINSES .SURFACE RUNOFF	MIXING; TRANSPORT TANKERS SPILLS TO YARD SURFACES	NOT REPORTED UNKNOWN (NOT ASSESSED)	RECYCLED TO THE FRASER RIVER VIA SURFACE DITCH
SOLIDS .FILTER DUST, DEBRIS	VENTILATION SYSTEM	NOT DETERMINED	HELD FOR DISPOSAL AS SPECIAL WASTE
.EMPTY CHLOROPHENOL BAGS	CHLOROPHENATE MIXING	EST. 3500	DISPOSED TO MUNICIPAL LANDFILL
GASEOUS .VENTILATION DISCHARGE	FILTER DISCHARGE	RATED 8000 ACFM @ 50 MG/CM	TO THE ATMOSPHERE

one shift/day, 5 days/week to produce the following major product lines:

. "Woodsheath" chlorophenate wood protection agent,
. end sealers for lumber,
. travel stain control packager (for lumber shipped by rail),
. plywood stains, and
. inks.

The first three of the above listed product lines (chlorophenate solutions, end sealer and travel stain control agent) constitute the major formulating activities at this site (about 30% of the total business activity for each product). Approximately 81,000 kilograms of tetrachlorophenol is used annually at the site to produce the Woodsheath product line and chlorophenate solution is mixed on most working days.

2.0 SITE ENVIRONMENT

2.1 LOCATION AND SETTING

Figure 1 shows the location of the Walker Brothers Plant. The plant occupies approximately 0.15 hectares south of Beresford Street in Burnaby. The site is generally in an area of industrial activity surrounded by commercial establishments and residences. The Walker Brothers site is bounded by Beresford Street on the north (with the B.C. Hydro Railway and the new A.L.R.T. Line directly across the street), by the Great West Paper Box Company on the west and south, by Kenneth Avenue and the Glidden Paint Warehouse beyond (owned also by SCM) on the east.

2.2 SITE SURFACES

The site is almost entirely occupied by the Walker Brothers Building. Access lanes around the building are paved with asphalt, as is a drum storage yard behind the building at the southeast corner. Beresford Street and Kenneth Avenue are both paved.

2.3 SOILS

No formal soil surveys of the site were known to the contacts and no information was available about the subsurface soils.

2.4 TOPOGRAPHY AND DRAINAGE

The site has a gentle slope to the south and east, with an estimated 2 to 3 meter drop in elevation from the northwest to the southeast corner. Surface drainage from the north (Beresford Street) enters storm drains at the front of the building and is conveyed to a surface drainage ditch which flows south from its point of origin at the southeast corner of the property. Storm runoff from the front drive and loading dock also discharge to this ditch through a subsurface drainage system (Figure 2). A sump in the roofed storage

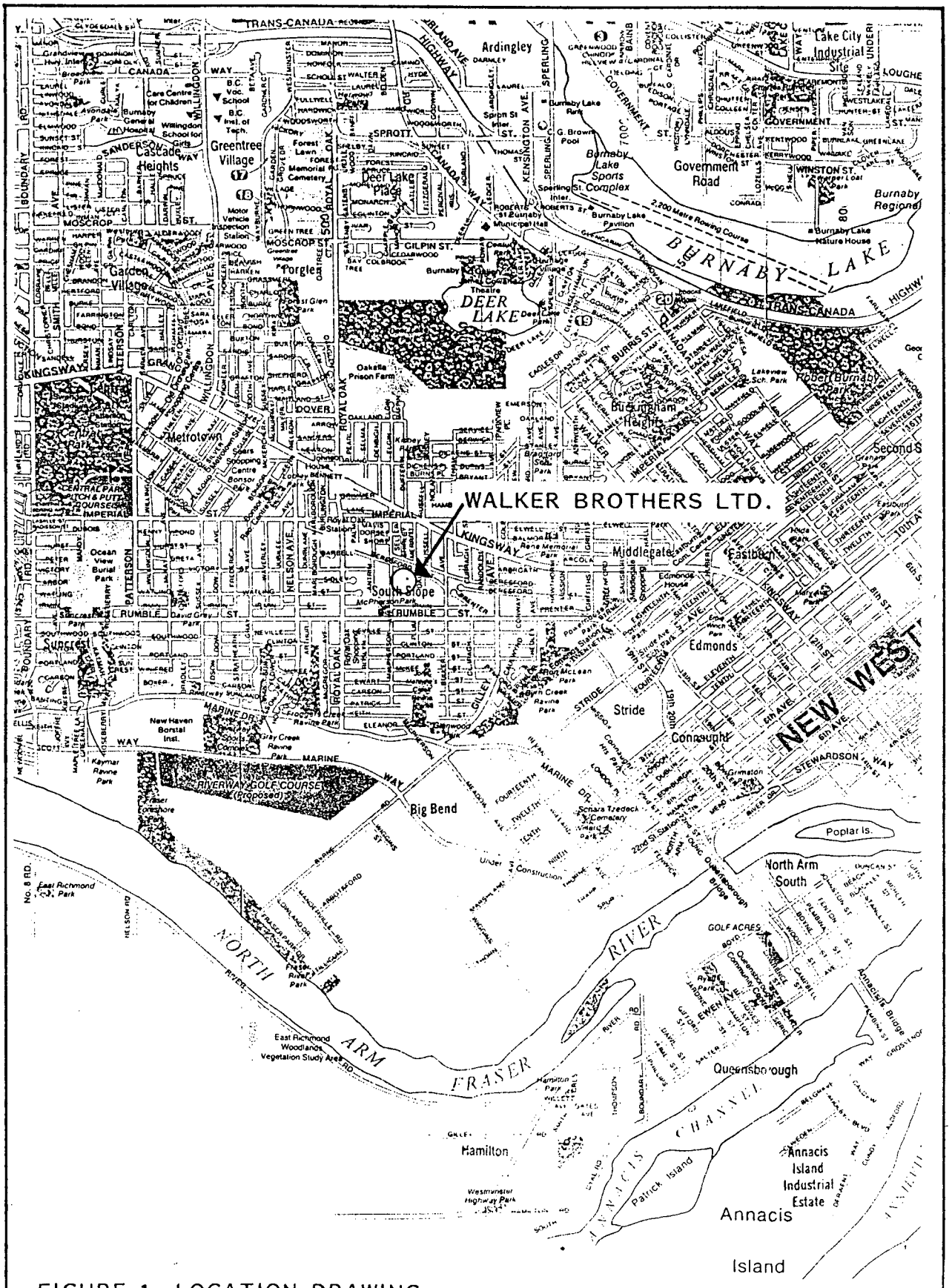


FIGURE 1: LOCATION DRAWING
WALKER BROTHERS LTD. BURNABY, B.C.

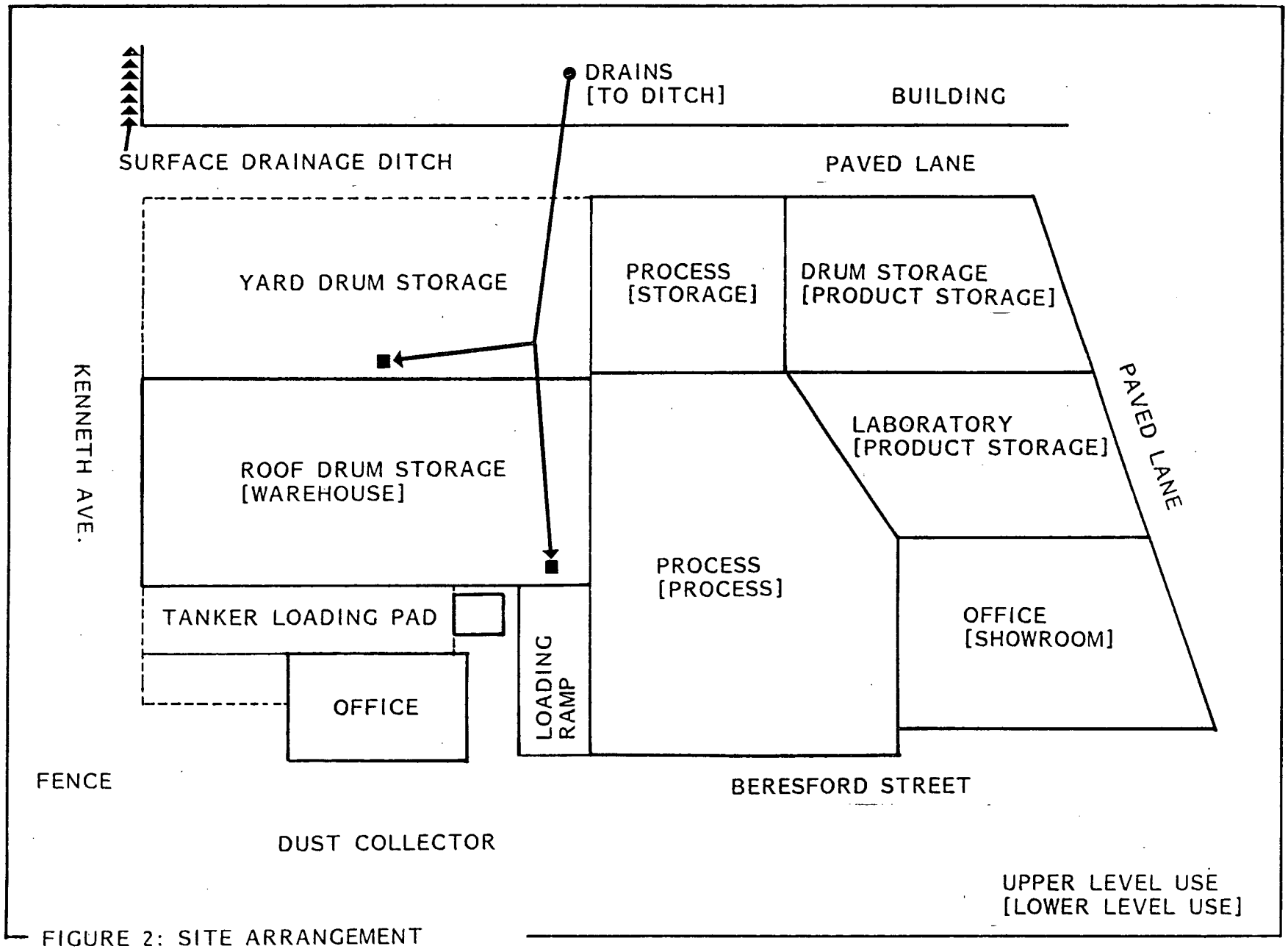


FIGURE 2: SITE ARRANGEMENT
WALKER BROTHERS LTD. BURNABY

area on the east end of the plant and a sump located in the drum storage yard also reportedly receive surface drainage and discharge to the surface ditch. The exact course of surface drainage beyond the visible ditch is not known, but it was reported that the runoff ultimately flows to the Fraser River. The ditch follows the western edge of Kenneth Avenue and turns west across Great West Box Company property at the juncture of Kenneth and Jermyn Streets.

2.5 SURFACE WATERS

There are no known surface waters (with the exception of the drainage ditch described in Section 2.4) on or near the site. The North Arm of the Fraser River lies approximately two kilometers to the south.

2.6 HYDROGEOLOGY

There was no available information about the hydrogeology of the site.

2.7 WELLS

There are no wells on site.

3.0 FACILITY DESCRIPTION

3.1 CURRENT FACILITY

Section 1.4 provides a summary of current operations of the facility. Primary activities include the formulation of Woodsheath chlorophenate solutions, lumber and sealers, travel stain control packager, stains and inks. The description of physical facilities in the following sections are concerned exclusively with operations for formulating and handling chlorophenate solutions.

3.1.1 GENERAL SITE ARRANGEMENT

Figure 3 shows the general arrangement of the Walker Brothers plant. All raw materials for chlorophenate formulation enter the facility in dry, bagged form. Materials arrive by flatbed truck and are stored in the adjacent Glidden Paint Warehouse. Bagged caustic and tetrachlorophenol are periodically transferred to the mixing area in the Walker Brothers plant.

The mixing area is located on the second floor of the Walker Brothers building. A variety of dry (bagged) chemicals are stored in the area for use as required. The process structure is concrete block, with wooden floors and ceiling. The floor has no drains and accesses the exterior through a loading entry on the front (north wall). The floor is overlaid with chipboard surface which is well-worn. Dry tetrachlorophenol, caustic and water are added to mixing tanks on the second level, mixed and discharged by gravity to a pumping station for transfer to storage tanks located on the first floor of the facility. Solution is then pumped to the filling room where small containers of solution are filled, or pumped to bulk tankers in the loading area. Solution is also shipped in 300 Imperial gallon "totes" which are filled in the loading area.

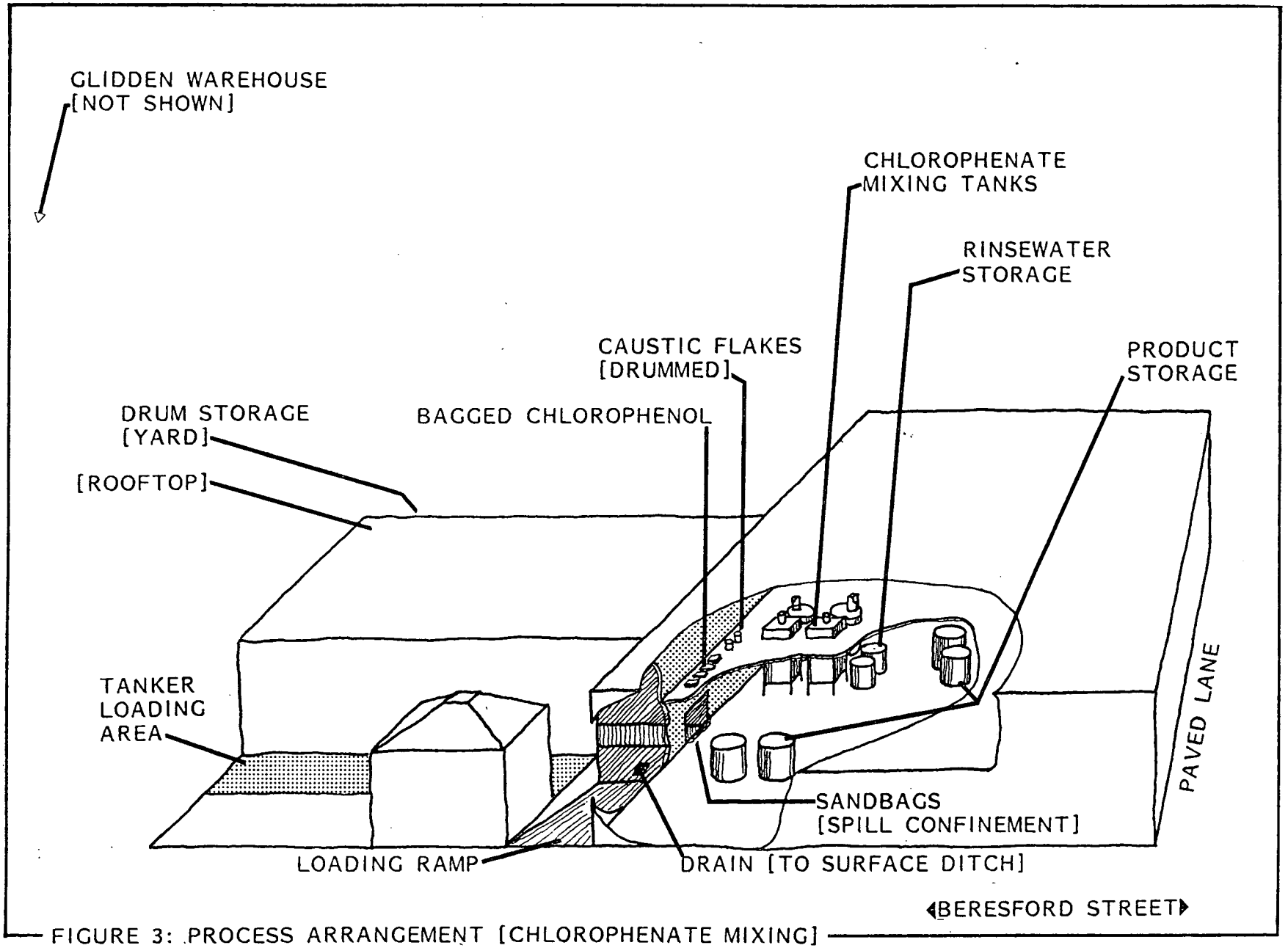


FIGURE 3: PROCESS ARRANGEMENT [CHLOROPHENATE MIXING]
WALKER BROTHERS BURNABY, B.C.

3.1.2 CHEMICAL STORAGE

Chlorophenol in bags is stored in the Glidden warehouse (a typical concrete floor multi-purpose warehouse) or in the mixing area in the Walker Brothers plant (described above). Empty totes are also stored in the Glidden Warehouse. Chlorophenate solution is stored in one of four 1,000 Imperial gallon fiber reinforced plastic tanks located on the main floor of the processing area.

3.1.3 CHEMICAL MIXING

The preparation of chlorophenate solution occurs in the four tanks which are centrally located in the process area (see Figure 3). Ingredients are added at the second floor level, and solution is transferred to storage tanks at the main floor level.

3.2 FACILITY DEVELOPMENT TO DATE

3.2.1 OWNERSHIP

The facility at the Burnaby site was originally built and owned by the Walker family. The Company was bought by Glidden Paint in 1964 and in turn purchased by the current owners, SCM (Canada) Limited.

3.2.2 PROCESS DEVELOPMENT

The original Walker Brothers plant (1948) was established to produce latexes and shake and shingle treatments for the forest industry. In the 1960's, the Company developed its high pressure spray system for applying water repellants to lumber (at that time chlorophenate was primarily applied by dipping). The product lines were expanded in scope and size over the years with development of the travel stain control packager in 1970-1972. In 1979, the Woodsheath formula was developed in cooperation with the Seaboard Corporation and the Company began marketing the pressure spray systems for chlorophenate application. The equipment and operations for the on-site formulation

of Woodsheath products have remained essentially unchanged since the company began this activity.

3.2.3 WASTE TREATMENT

Contaminated waters are returned to process and there are no waste treatment facilities at the site.

3.3 PLANNED DEVELOPMENT

No specific plans for process alteration or expansion were indicated during the site visit.

4.0 PROCESS INFORMATION

4.1 PRODUCT SOLUTIONS

Small quantities of pentachlorophenol are added to wood sealers produced at this site. Much larger quantities of tetrachlorophenol are used in the production of chlorophenate sapstain control solutions. Products which contain chlorophenol as an active ingredient are summarized in Table II.

The total volume of tetrachlorophenate solution produced during July 1, 1983 to June 30, 1984 was 471,000 kilograms expressed as a 17.26% concentrate. The total solution volume depends on the mix of products actually produced. Chlorophenate solutions are mixed on most working days at the plant.

4.2 PROCESS RAW MATERIALS

TETRACHLOROPHENOL (SOLID)

Sodium tetrachlorophenate solution is prepared from 50 pound bags of technical tetrachlorophenol manufactured by Reichhold Chemicals Inc. (Tacoma) and supplied by Reichhold Limited (Port Moody). 81,300 kilograms of tetrachlorophenol was used in the twelve month period from July 1, 1983 to June 30, 1984.

PENTACHLOROPHENOL (SOLID)

Technical pentachlorophenol is supplied in 50 pound bags by Reichhold Limited (manufactured by Reichhold Chemicals Inc.). 680 kilograms of pentachlorophenol was used in the twelve month period identified above.

CAUSTIC

Caustic is supplied as a dry flake in metal drums.

TABLE II: PRODUCTS CONTAINING CHLOROPHENOLS
WALKER BROTHERS BURNABY, B.C.

BRAND NAME	ACTIVE INGREDIENT	CONCENTRATION [% BY WEIGHT]	REGISTRATION NUMBER*
WOOD SEALER	PENTACHLOROPHENOL	3.93	16917
	OTHER CHLOROPHENOLS	0.46	
TETRA CONCENTRATE	SODIUM TETRACHLOROPHENATE	17.26	16916
	OTHER CHLOROPHENATES	4.67	
WOODSHEATH CLEAR	SODIUM TETRACHLOROPHENATE	10.73	16935
	OTHER CHLOROPHENATES	2.86	
WOODSHEATH SEABRITE	SODIUM TETRACHLOROPHENATE	10.00	18019
	OTHER CHLOROPHENATES	2.67	
WOODSHEATH CLEAR	SODIUM TETRACHLOROPHENATE	5.10	14874
	OTHER CHLOROPHENATES	1.36	
WOODSHEATH CHERRY BROWN	SODIUM TETRACHLOROPHENATE	5.10	14874
	OTHER CHLOROPHENATES	1.36	

*REGISTRATION UNDER THE PEST CONTROL PRODUCTS ACT

PROCESS WATER

Process water is drawn from the Burnaby municipal supply.

4.3 PROCESS DESCRIPTION

4.3.1 SOLUTION PREPARATION

Chlorophenate solutions are prepared in the four mixing tanks identified and shown schematically in Figure 3. The two 500 lgallon tanks can be used for dispersion of dry ingredients in liquid solution while the two 1000 lgallon tanks have only mixing capability. As a consequence, several transfer operations between the tanks are required for the preparation of the final solution. The preparation of chlorophenate solution typically consists of the following steps:

1. Drummed caustic and bagged tetrachlorophenol are added to the two 500 gallon tanks (at the second floor level) to prepare two batches of 400 lgallons each.

2. The contents of both small tanks (800 gallons) are pumped over to one of the 1000 gallon tanks.

3. 200 gallons is drawn back to one of the small tanks for addition and dispersal of the color base.

4. The color concentrate is then added back to the solution in the large tank and blended.

5. The blended concentrate is split between the two large (1000 gallon) tanks, diluted to final strength and water repellant is added.

The final solution is then drained by gravity through a sock filter (at the main floor level) into a small portable tank. The tank serves as a reservoir for a diaphragm pump which transfers the solution to one of four 1000 lgallon storage tanks on the main floor or directly to a truck tanker.

4.3.2 CONTAINMENT

No permanent positive spill or drip containment is provided for the chlorophenate mixing or storage tankage. The working area surrounding the ingredient addition ports on the tanks (second level) is surfaced with worn chipboard over wooden flooring. Tank overflow of liquid at this level would soak into the flooring material or seep through the floor to the main floor level.

The main floor is essentially at grade level for the front of the facility and approximately 2 meters above grade level for the eastern access door to the loading dock. The main floor is concrete and no curbing or dyking is provided for any of the mixing and storage tanks. There are no floor drains in the process area. However, there is a storm drain at the foot of the vehicle drive ramp which is located approximately 5 meters from the mixing tanks (through the access door to the loading dock). A row of sand bags has been placed across the access door to retard minor spillage from flowing through the doorway, over the edge of the dock and to the floor drain below. The floor drain receives surface runoff from the driveway and reportedly discharges to the surface drainage ditch east of the plant (see Section 2.4).

5.0 POLLUTION CONTROL AND ASSESSMENT

5.1 PROCESS WASTES AND RELEASES

No liquid wastes are produced by the chlorophenate formulation process. Rinse waters from formulating tanks and from the cleanout of transport tankers are collected and saved in a 1000 gallon tank. These rinse waters are analyzed and reused in the preparation of subsequent batches of product.

There are no direct air emissions from the formulating process. Local hoods over the mixing tanks are used to ventillate the area. These hoods exhaust to the atmosphere through a dust collection system (a Pulsejet fabric filter collector rated at 8000 ACFM with an air/cloth ratio of 6.7:1). The discharge is governed by GVRD Waste Management Permit VA-291, and the controlled parameters are particulate matter (50 mg/m3), opacity and odour.

Solid waste residues generated at the facility include the dusts from the dust collection system (principally pigment dusts), filters and some sludges. These materials are sealed in 45 lgallon metal drums and held on-site pending identification of satisfactory disposal. No drums have been removed from the site to date and 30 to 35 drums are currently in storage.

Additional solid wastes generated at the plant include sweepings of solid raw materials which are normally reused . Empty raw material bags (including chlorophenol bags) are discarded with other conventional solid wastes and are removed by ALINE Disposal.

5.2 SITE CONTAMINATION

The site contacts knew of no monitoring for chlorophenate residues in the vicinity of the site.

5.3 CHEMICAL SPILLS

5.3.1 SPILL HISTORY

It was reported that minor spills have occurred within the facility and these have generally been cleaned up without difficulty. On at least one occaision chlorophenate escaped to the storm drain system and entered the drainage ditch which is located on the east side of the plant. The spill was reportedly intercepted by blocking the ditch. There is no written documentation of these events and additional details were not known to the site contacts.

5.3.2 SPILL CONTAINMENT

The spill containment features of the facility are described in detail in Section 4.3.2. The configuration of the facility is such that minor spills would be confined to paved areas within the building, but localizing such spills would be difficult because of the two-level construction (with wooden floors on the second level) and the lack of containment curbing. The main floor is isolated from the exterior only by temporary sandbag curbing and a major spill would probably quickly escape to the storm drain at the foot of the loading dock (and thence to the surface drainage ditches leading to the Fraser River).

5.3.2 SPILL RESPONSE

The Company did not have a written spill contingency plan or a designated emergency coordinator at the time of the site visit. The site contacts reported that a written contingency plan is under preparation (as a modification of the plan used by the Toronto plant of the Company).

6.0 WORKER PROTECTION

Workers were observed in the course of their normal duties in preparing a chlorophenate batch during the 4 October site visit. Appropriate protective equipment was used and workers exercised reasonable care in carrying out the required operations. However, the age of the facility and the unsophisticated design of transfer equipment generally create the potential for dangerous worker exposure to the chemicals in use. In particular, the use of chipboard over wood flooring on the second level (where ingredient chemicals are stored and added to mix tanks) makes the effective cleanup of dry or wet spillage difficult . The flooring is worn and readily absorbs chemical residues. Consequently, the flooring acts as a continual potential source of exposure to the residues of the numerous chemicals which are handled at the facility. The inherently unkempt appearance of the flooring also tends to reinforce the tendency to maintain a substandard level of housekeeping in the working area.

The design of the chlorophenate mixing process also requires numerous manual or open transfer operations which are points of exposure for workers. For example, the final chlorophenate solution is transfered by gravity through an exposed sock filter to an small open tank on the first level.(The tank serves as the feed reservoir for a portable pump which transfers the solution to the product storage tanks). During the transfer the worker must continually manipulate the sock filter with his hand to prevent clogging. Although protective equipment is worn during this procedure, there is high potential for the worker to be drenched with chlorophenate concentrate and the creation of high aerosol levels in the area is likely. It is conceivable that a mishap contaminating the operator might also be accompanyed by a spill of solution at the same time. The storm drain is nearby, and such a situation would create a need to assist the operator as a first priority, increasing the likelihood of chemical release to the exterior drain system.

The Company requires that all employees undergo a complete physical examination at two year intervals. Details of the parameters monitored could not be provided, but the site contact reported that he presumed the check to include monitoring of blood and urine for residues of chemicals handled at the facility (for example, lead, heavy metals, chlorophenol). There is reportedly no indication from the physical exams that chlorophenols were present in the blood of workers.

The WCB has undertaken workplace monitoring (1982) for chlorophenols, Stoddard solvent, rubber solvent and nuisance dusts. The site contacts noted that the report indicated no overexposure (relative to WCB limits) for the chemicals monitored. The last WCB inspection was reportedly about 18 months prior to the site visit reported herein. It was indicated that Walker Brothers plans to institute an in-house program to monitor the workplace for contaminants. The program was to be initiated in December 1984. Personal sampling devices are to be used for sample collection, with analytical work and interpretation provided by the SCM research facility in Cleaveland, Ohio.

There is no formal written training program at the facility. However, workers are verbally instructed about safety requirements. The use of respiratory canisters is required when operators mix or transfer Woodsheath products. In addition, a full face shield is mandatory when chlorophenol bags are cut and emptied. Gloves, impermeable aprons and coveralls are also used.

Emergency eyewash stations, eye rinse solution and emergency showers are provided in the working area. Washing is required prior to eating or using the washrooms. Coveralls are required in the plant. Five pairs are issued to each employee and laundering is provided weekly by the Company. It was reported that employees are generally conscientious in following the required safety precautions.

7.0 FIREFIGHTING

The Walker Brothers facility is a wooden frame building of older design. The Building is reportedly fully sprinklered and 14 ABC carbon dioxide fire extinguishers are located in the building. The sprinkler system and alarms are checked twice monthly and the Burnaby Fire Marshal inspects the facility twice yearly. The Fire Marshal has surveyed the plant to determine the location and identity of all chemicals.

8.0 REGULATORY AGENCY ACTIVITY

The limited involvement of regulatory agencies with Walker Brothers is briefly summarized below:

The B.C. Workers Compensation Board has provided some inspections and assessments of the Walker Brothers Facility although documentation for this involvement could not be obtained (see also Section 6.0).

The Ministry of the Environment (Waste Management Branch) has apparently had no involvement at the Walker Brothers Site. The Pesticide Control Branch has issued licenses for authorized pesticide handlers at the site.

The Environmental Protection Service has had no prior involvement with the Walker Brothers Facility.

The GVRD has issued a permit for the discharge of the ventilation system for the paint pigment loading operation. (This ventilation system also serves the chlorophenate mixing area). The GVRD has also reportedly done dye tracer tests to confirm the discharge of drains at the site to the surface ditch system.

9.0 SUMMARY ASSESSMENT

Table III presents the summary assessment of the Walker Brothers Facility. The overall containment design of the facility has been rated as marginally acceptable. Sincere attempts have been made to compensate for design deficiencies with careful operating practice. However, the containment at the facility is not considered to be effective without careful vigilence to detect spillage and leakage. Furthermore, the configuration of the facility would seriously constrain the control and cleanup of a major spill. In view of the ultimate discharge of escaped chemicals to the Fraser River, it is recommeded that the facility should undertake a program of design improvements to provide positive containment for chlorophenates stored and handled at the facility.

The overall management of chemical releases to the environment is rated as acceptable subject to the comments of this section. The facility has a washwater recovery system in place to allow the reuse of all liquid rinses from operations at the facility. Solid residues are drummed and stored securely on site, although local disposal of this waste is not available. Empty chlorophenol bags are disposed of with conventional solid refuse . This practice is unacceptable and should be discontinued immediately. Fugitive vapors and dusts in the workplace are controlled with a ventilation system which is vented through a filter and dust collector. The discharge is controlled by GVRD permit, although there apparently is no monitoring data to support the proper performance of the unit. The releases of chlorophenate or other chemicals to the environment have not been assessed through monitoring of surface runoff. It is recommended that a regular program of runoff monitoring be implemented to detect and assess any releases of chemical from the site.

The overall management of chemicals in the workplace is rated as acceptable, although significant improvements in worker protection would result from addressing the concerns noted in Section 6.0 and above. It is recommended that consideration be given to a program of

TABLE III: SUMMARY ASSESSMENT OF CHLOROPHENATE FORMULATION
WALKER BROTHERS BURNABY, B.C.

CURRENT CHEMICAL USE	TETRACHLOROPHENOL (WOODSHEATH PRODUCTION)	81,300 KILOGRAMS/YEAR (JULY '83 TO JUNE '84)
	PENTACHLOROPHENOL (OTHER PRODUCTS)	680 KILOGRAMS/YEAR
OVERALL CHEMICAL MANAGEMENT	WORKPLACE	ACCEPTABLE (SEE COMMENTS IN TEXT)
	SITE ENVIRONMENT	ACCEPTABLE (SEE COMMENTS IN TEXT)
OVERALL SPILL CONTAINMENT FEATURES		MARGINALLY ACCEPTABLE (SEE TEXT FOR SPECIFIC RECOMMENDED IMPROVEMENTS)
RELEASES TO THE ENVIRONMENT	SOURCES	ENVIRONMENTAL SIGNIFICANCE
TO LAND	EMPTY CHLOROPHENOL BAGS	UNKNOWN (SEE PROCESS WASTES)
TO WATER	SURFACE RUNOFF	UNKNOWN (SURFACE RUNOFF HAS NOT BEEN MONITORED OR ASSESSED FOR CONTAMINATION)
TO AIR	VENTILATION SYSTEM	UNKNOWN (NOT ASSESSED)
PROCESS WASTES	SOURCE (DISPOSAL)	ENVIRONMENTAL SIGNIFICANCE
LIQUID	PRODUCT RINSES (RECYCLED)	NONE
SOLID	EMPTY CHLOROPHENOL BAGS (TO MUNICIPAL REFUSE DISPOSAL)	UNKNOWN. THIS PRACTICE IS UNACCEPTABLE IN PRINCIPLE AND SHOULD BE DISCONTINUED. EMPTY BAGS SHOULD BE TREATED AS SPECIAL WASTE
	FILTER DUST, FILTERS (DISPOSED AS SPECIAL WASTE)	NONE
GASEOUS	VENTILATION SYSTEM (FILTERED)	UNKNOWN.
WORKER EXPOSURE	SOURCES	SIGNIFICANCE TO WORKERS
TO LIQUID	ROUTINE MIXING ACTIVITIES	LOW IF PROPER PRECAUTIONS ARE FOLLOWED DESIGN IMPROVEMENTS WOULD REDUCE POTENTIAL EXPOSURE
	SPILLS	LOW IF PROPER PRECAUTIONS ARE TAKEN
TO AEROSOLS OR VAPORS	ROUTINE MIXING ACTIVITIES	LOW IF PROPER PRECAUTIONS ARE TAKEN

design improvements which would decrease the extent of direct worker contact with chemicals (i.e., conversion to closed mixing and transfer operations).

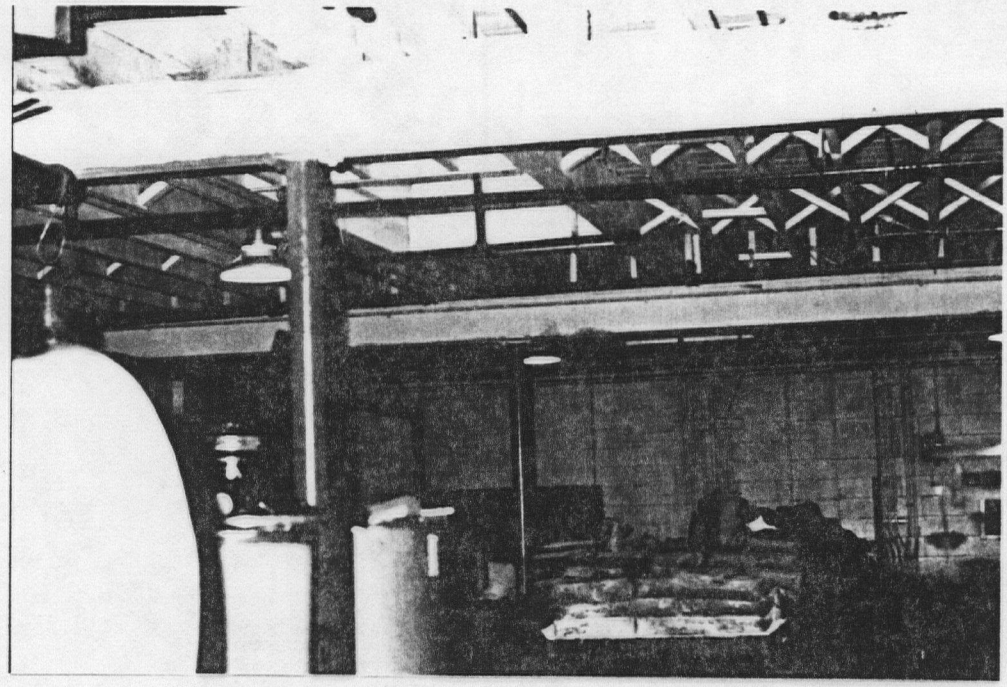
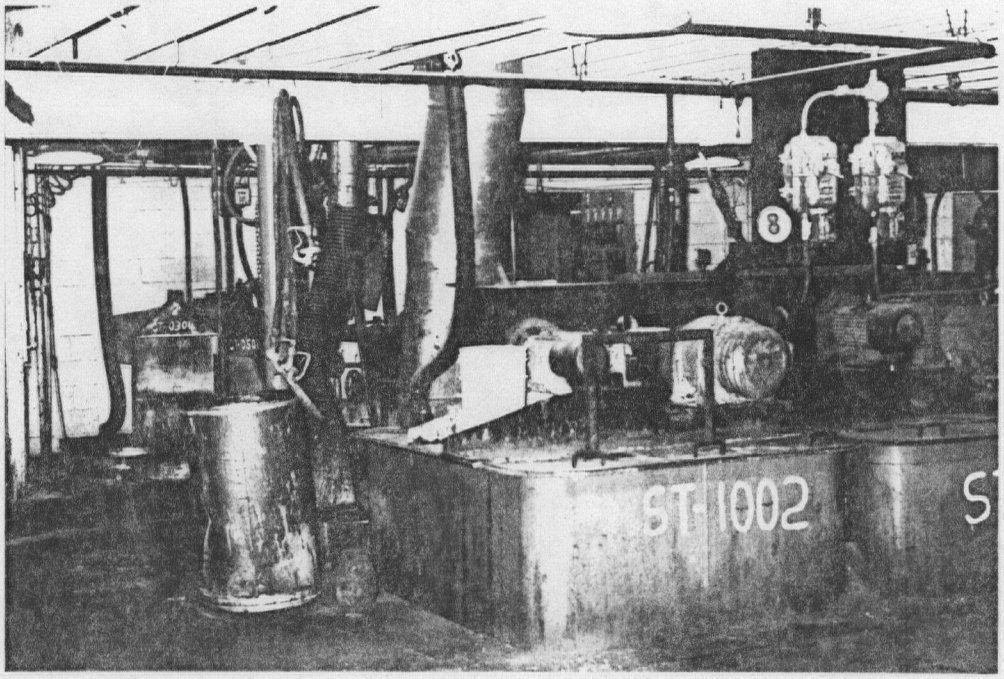


PLATE A:CONSTRUCTION OF THE PROCESS AREA, INTERIOR UPPER LEVEL

PLATE B: TWO 1000 GALLON CHLOROPHENATE MIXING TANKS, UPPER LEVEL
[TWO 500 GALLON CHLOROPHENATE MIXING TANKS DIRECTLY BEHIND]



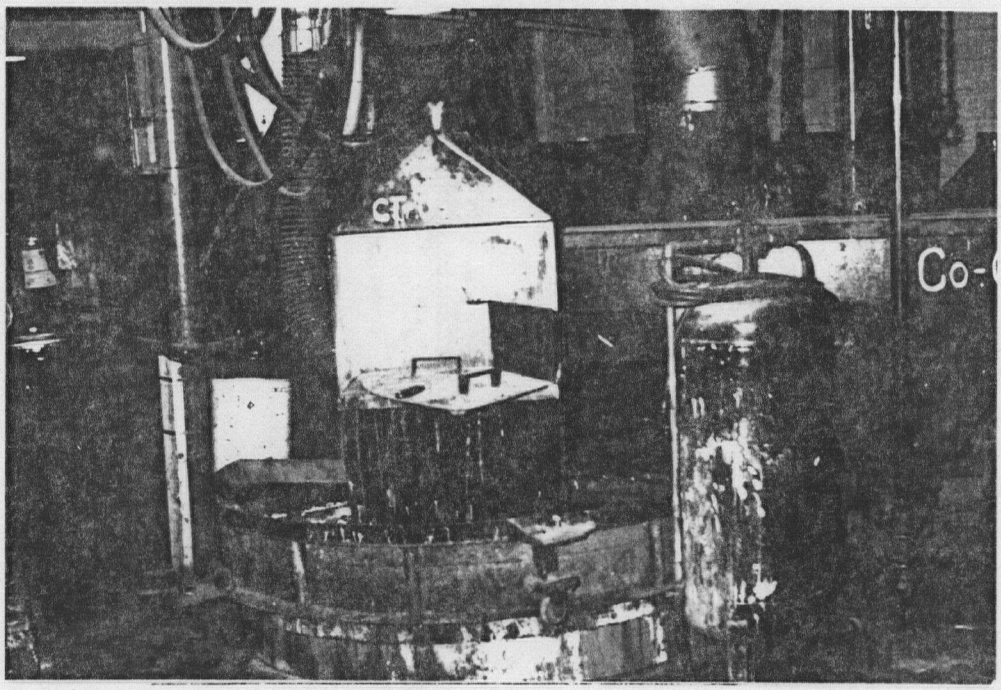


PLATE C: ONE OF TWO 500 GALLON CHLOROPHENATE MIXING TANKS, UPPER LEVEL
[SECOND TANK TO RIGHT, 1000 GALLON TANKS BEHIND]

PLATE D:CAUSTIC FLAKE, ADJACENT TO MIXING TANKS, UPPER LEVEL
[1000 GALLON TANK LEFT, 500 GALLON TANK RIGHT]

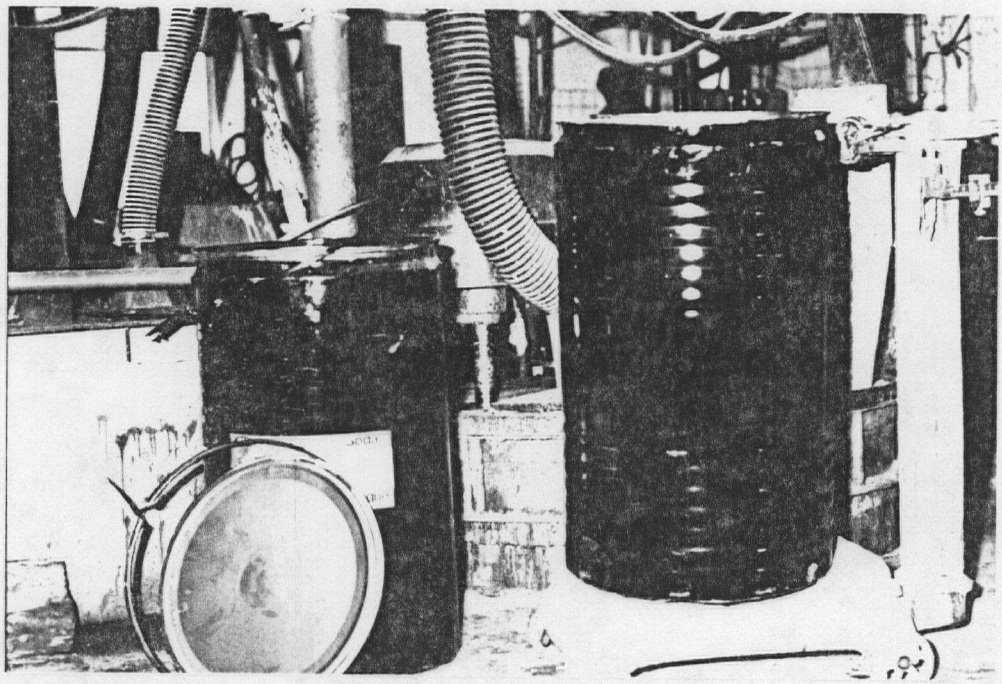
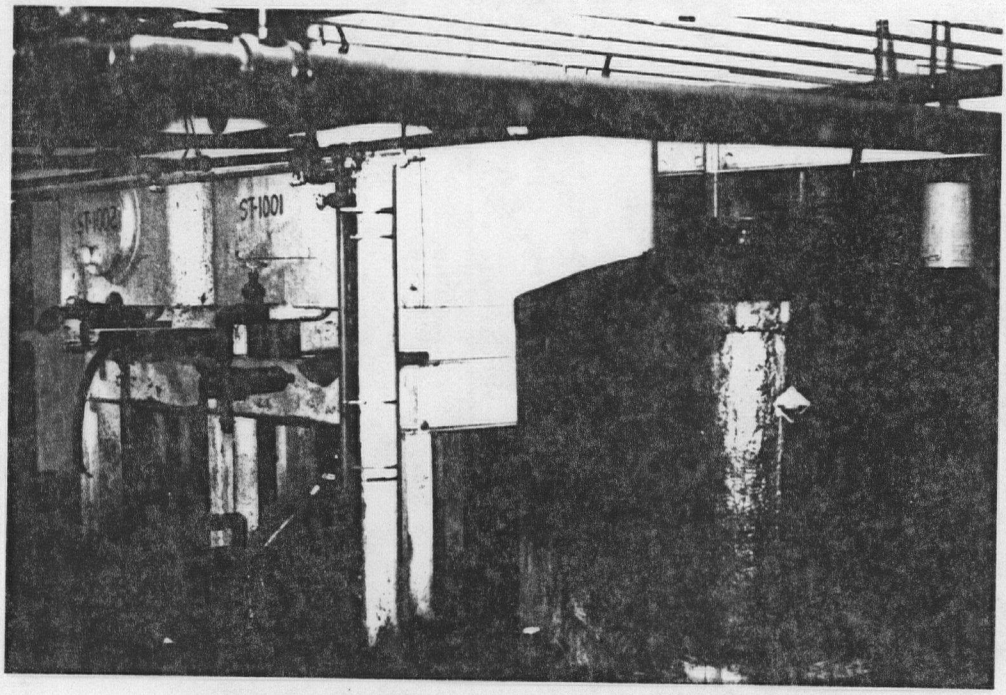


PLATE E:PERSONNEL PROTECTION EQUIPMENT FOR CHLOROPHENATE MIXING
[UPPER LEVEL]

PLATE F:TWO 1000 GALLON CHLOROPHENATE MIXING TANKS, LOWER LEVEL [RINSEWATER RECOVERY TANK, RIGHT FOREGROUND]



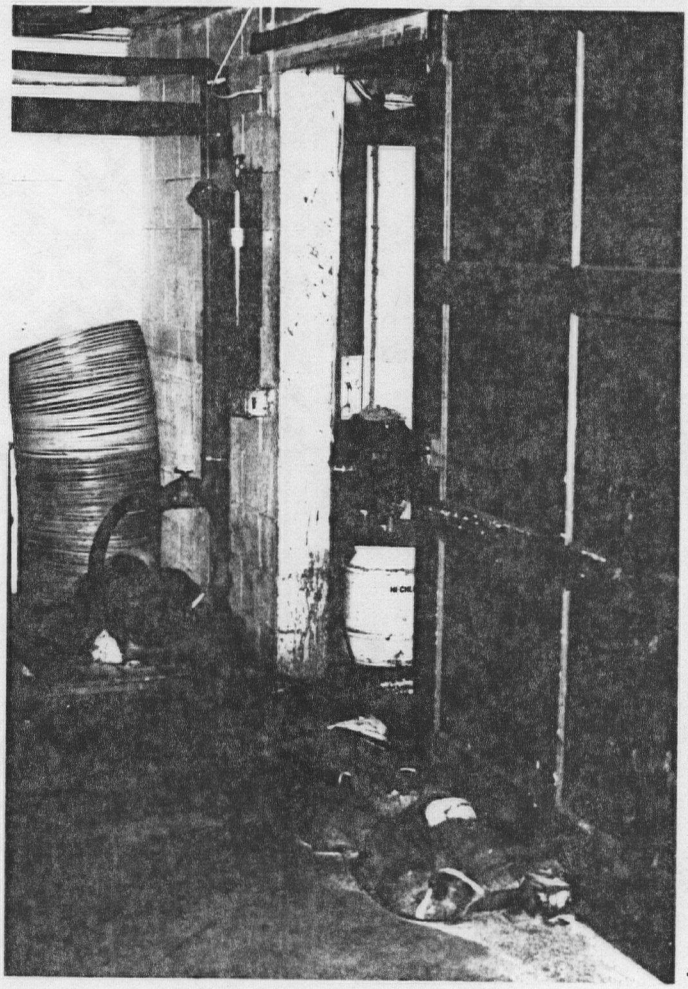
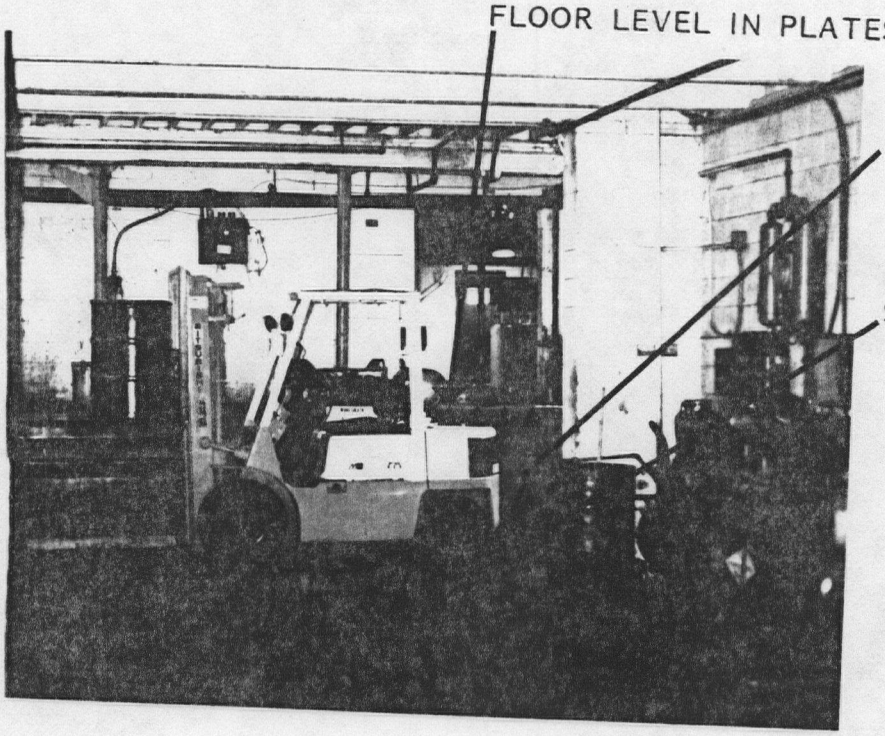


PLATE G:AREA EXIT, 5 METERS LEFT (EAST) OF TANKS IN PLATE F [BEYOND THIS DOOR, A SUBGRADE LOADING DOCK RAMP RISES TO BERESFORD STREET ON THE LEFT. A SURFACE DRAIN IS LOCATED AT RAMP LEVEL DIRECTLY BEYOND THE DOOR-SEE PLATE H.]

PLATE H: THE OPPOSITE SIDE OF THE EXIT DOOR IN PLATE G, FACING WEST [THE LOADING RAMP RISES TO STREET LEVEL ON THE RIGHT]



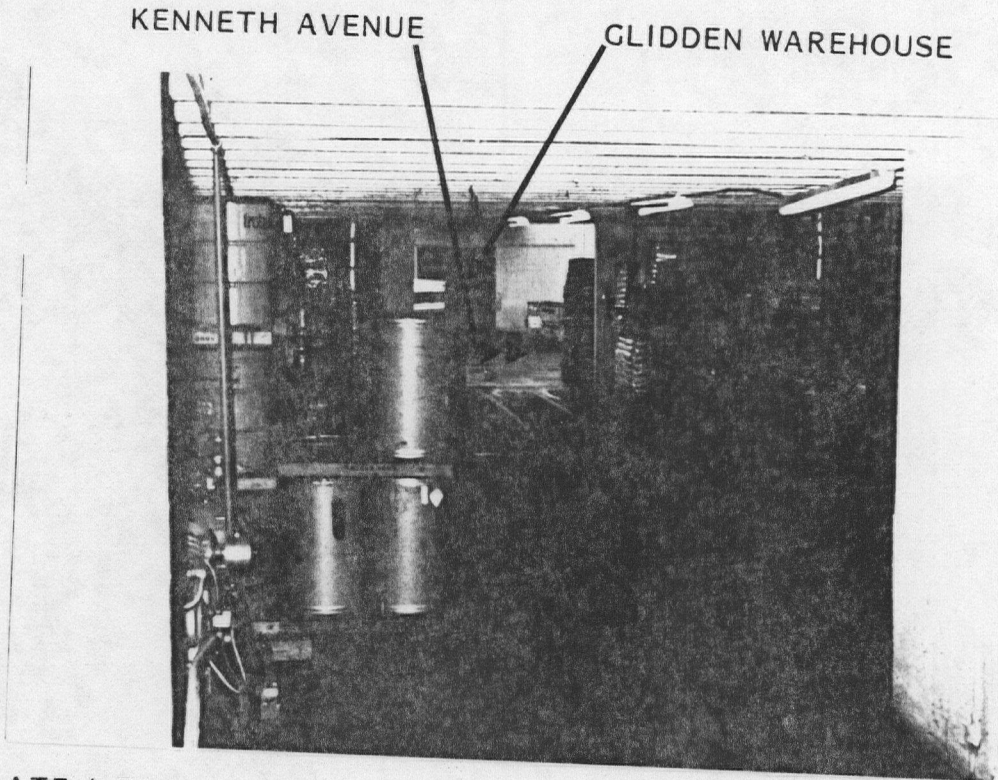


PLATE I: FACING EAST, WAREHOUSE AREA SHOWN IN PLATE H [KENNETH AVENUE AND GLIDDEN WAREHOUSE BEYOND]

PLATE J:EXTERIOR DRUM STORAGE YARD
[NOTE ROOFTOP DRUM STORAGE TO LEFT]

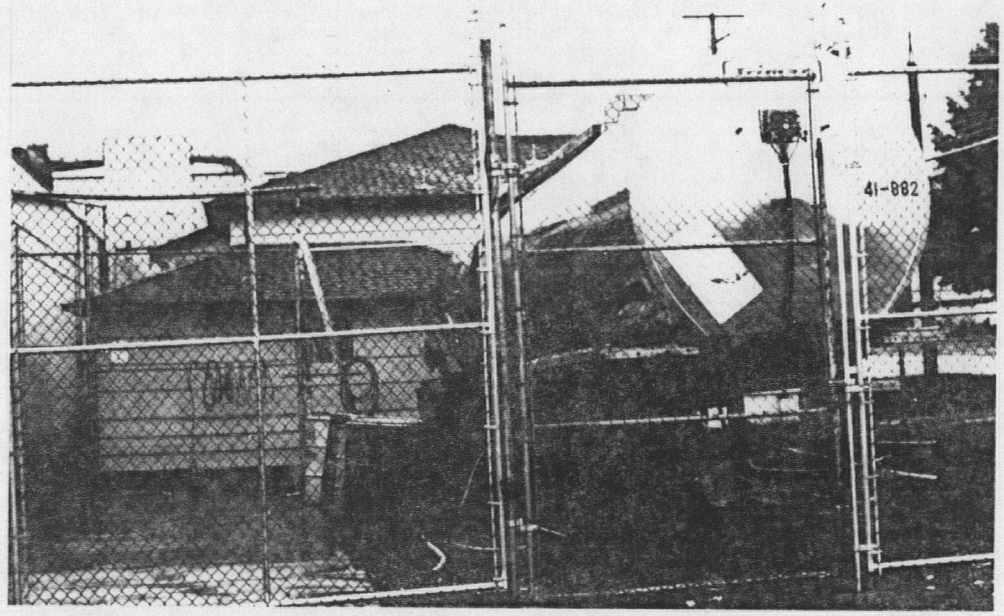
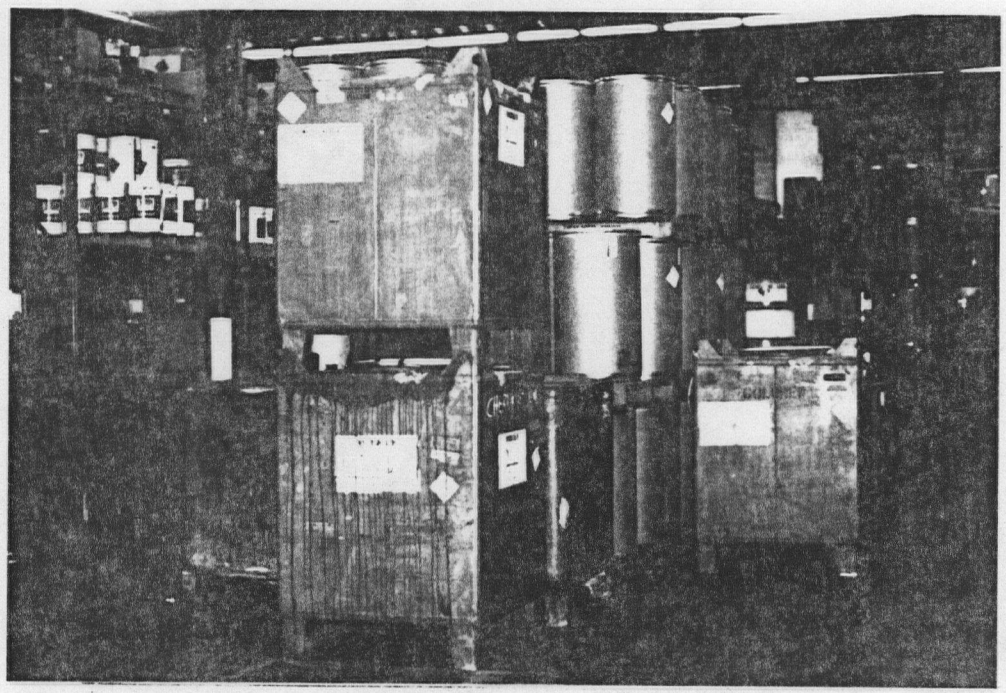


PLATE K:CHLOROPHENATE PRODUCT LOADING PAD [LEFT]



PLATES L and M:BAGGED CHLOROPHENOL AND CHLOROPHENATE TOTE STORAGE [GLIDDEN WAREHOUSE]