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THE COLLECTION, TREATMENT AND DISPOSAL OF HAZARDOUS AND BULKY WASTES IN THE NORTHWEST TERRITORIES

by

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Department of Civil Engineering

A thesis submitted in conformity with the requirements
for the Degree of Master of Applied Science
in the University of Toronto

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Abstract

In the past decade, many jurisdictions have attempted to estimate quantities and types of hazardous wastes generated within their boundaries. Similar studies done in the Northwest Territories (NWT) are out-of-date, incomplete or specific to only one type of waste or geographical location. In 1990 an industry, business and community survey was conducted to determine types and quantities of hazardous wastes generated and stored in the NWT and currently used disposal methods for these wastes. From this data, major hazardous waste types were determined and guidelines set up for their collection, treatment and disposal.

This survey revealed that the highest quantity hazardous wastes generated were:

- waste oil;
- contaminated fuels;
- oil/water mixtures;
- fuel tank sludges;
- oil filters;
- acid batteries;
- spent solvents;
- anti-freeze;
- waste paint;
- drummed wastes; and
- bulky wastes.

In many regions, disposal of these wastes may be routine, but waste disposal in arctic and sub-arctic regions presents unique difficulties. Severe climate, expense of transportation, isolation and small quantities of wastes generated can make standard solutions expensive, difficult, or impossible to apply. Unique solutions are needed for northern waste disposal.

This study contains background information obtained from existing literature and personal communication, hazardous waste inventory data obtained from the survey, guidelines for the collection, treatment and disposal of the most common hazardous wastes, and also includes guidelines for the disposal of bulky wastes, and recommendations for future work. The aim of this report is to give an overview of hazardous wastes in the NWT and provide low-cost, on-site or local disposal options which reduce or eliminate adverse health effects and environmental damage caused by hazardous wastes.

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FOREWORD

Statement of the Problem

"I brought you into a fertile land to eat its
fruit and rich produce.
But you came and defiled my land and made my
inheritance detestable."
(Jeremiah, 2:7, NIV)

The Canadian Arctic is considered by many to be a vast wilderness, untouched by human activity. Most people believe that a place such as the Northwest Territories could not possibly have a problem with hazardous wastes. However, since the first white people arrived in the Arctic, non-perishable materials have been brought into the north and due to the high cost of transportation many of these items are still there.

No community is free from hazardous and bulky wastes. Used oil, acid batteries, contaminated fuels, fuel drums, vehicles, appliances, animal carcasses and human sewage are some of the problem wastes in the arctic.

The Government of the Northwest Territories (GNWT) is a relatively new organization which faced a large number of problems when it was formed. It is understandable that hazardous wastes have been neglected until recently. The Department of Renewable Resources, Pollution Control Division, is doing work in the areas such as waste oil, spill clean-up and hazardous waste disposal for industries and communities. The Department of Municipal and Community Affairs (MaCA) has also recognized that work should be done in this area, and has commissioned and funded this study on hazardous wastes in the

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The study consists of:

- a literature review and personal communication to evaluate existing background information;
- the development, distribution and analysis of a questionnaire to obtain an inventory of hazardous wastes generated and stored. The survey was also used to determine methods currently used to dispose of hazardous wastes;
- site visits to selected communities to view waste disposals sites and discuss the problems of and possible solutions to hazardous wastes in different geographical locations and situations; and
- the development of guidelines for collection, storage, treatment and disposal of hazardous wastes in the NWT.

Organization of the Report

This report progresses logically through the various steps of the study.

Part I: Background of the Study compiles the information obtained from personal communication and literature review. It reviews:

- definitions of hazardous wastes;
- hazardous wastes accumulated, transported and generated in the NWT;
- existing solid waste disposal practices and problems in the NWT;
- existing regulations governing hazardous waste disposal in the NWT; and
- existing literature on hazardous wastes and solid waste disposal in the NWT.

Part II: Survey Development and Results describes the process of developing and evaluating a hazardous waste questionnaire by explaining:

- the inventory method;
- the identification and classification of potential hazardous waste generators;
- the process of designing the questionnaire;
- exclusions from the study; and
- the survey results.

Part III: Guidelines for Collection Treatment and Disposal of Selected Hazardous Wastes in the NWT explains the results of improper disposal of hazardous wastes. It also outlines:

- disposal technologies which are applicable in the NWT;
- methods of storage, collection and transportation of hazardous wastes; and
- disposal alternatives for some of the more common wastes.

Part IV: Recommendations includes recommendations for hazardous waste disposal facilities, suggestions for future work and a complete bibliography.

The **Appendices** include:

- a glossary of terms;
- a glossary of hazardous substances;
- a copy of the questionnaire used in conjunction with this study;
- some of the survey results; and
- some household hazardous waste minimization suggestions.

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I cannot forget where my real help comes from.

> "Fear thou not for I am with thee. Be not dismayed for I am thy God. I will strengthen thee, yea I will help thee, yea I will uphold thee in the right hand of my righteousness." (Isaiah 41:10, KJV)
>
> "I can do all things through Christ who strenghteneth me." (Phillipians 4:13, KJV)

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A & A Service and Equipment Ltd.	G. Allen
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R.J.K. Mobile Mechanics Inc.	H.G. Knuger

Taylor & Associates Ltd.	B. Taylor
T.C. Enterprises	Elaine Grundy
Treeline Aviation Services Ltd.	Les Roth
Tri Com Communications Ltd.	Robert Lyle
Westown Tire	Ken Puh
Western Cartage and Storage	Tex Meidl
Yellowknife Photo Centre Ltd.	Bob Wilson
Yellowknife School District #1	D. Johnson
Y.K. Auto Body	Roy
Y.K. Centre Dry Cleaners	Kevin

LIST OF ACRONYMS AND SHORT FORMS

APCA	Air Pollution Control and Hazardous Wastes Management Association
BACT	Best Available Control Technology
B.C.	British Columbia
°C	Degrees Celsius
cm/s	centimetres per second
CPPI	Canadian Petroleum Products Institute
CUCD	Consolidated University of California at Davis
DDT	(see Appendix B)
DEW-line	Distant Early Warning line
DND	Department of National Defense
DPW	Department of Public Works
DRR	Department of Renewable Resources
EARP	Environment Assessment and Review Process
EP	Department of Environmental Protection
EPS	Environmental Protection Service
HHW	Household Hazardous Wastes
GNWT	The Government of the Northwest Territories
g/cm^3	grams per cubic centimetre
kg	kilograms
kg/hr	kilograms per hour
kg/t	kilograms per tonne
kg/yr	kilograms per year
km	kilometres
L	litres
L/yr	litres per year
m	metres
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
MaCA	Department of Municipal and Community Affairs
NCPC	Northern Canada Power Corporation
NGO's	Non-Government Organizations
NIV	The New International Version of the Bible
NWT	The Northwest Territories
Ont.	Ontario
PCB's	Poly Chlorinated Biphenyls (see Appendix B)
PERC	Perchloroethylene
pH	(see Appendix B)
POL	Petroleum, Oil and Lubricants
ppm	Parts per Million
Que.	Quebec
SAO	Senior Administrative Officer
SIC	Standard Industrial Classification
t	tonnes (1,000 kg)
t/hr	tonnes per hour
t/yr	tonnes per year
TDGA	Transportation of Dangerous Goods Act
WHMIS	Workplace Hazardous Materials Information Sheet
yr	year

PART I

BACKGROUND OF THE STUDY

CHAPTER 1

INTRODUCTION

The initial obstacle in developing this study on hazardous wastes in the Northwest Territories was in obtaining background information. Previously available data on this subject had become out-of-date, or was incomplete, or specific to only one type of waste or geographical location. Personal communication also revealed a lack of information and the need for work in this area.

The Government of the NWT is a relatively young political body which faced a great deal of problems when it was brought into being. It is understandable that attention to the problem of hazardous wastes was neglected for other more pressing concerns. Recently it has become obvious that problems such as abandoned military sites, fuel and oil spills, bulky wastes, abandoned mines, oil drilling sites and industrial and community hazardous wastes must be addressed.

The Arctic environment presents additional problems with solid waste disposal. Extreme climate, isolation and the sparse population density increase the expense and complexity of landfilling, transportation and disposal of any type of waste.

Part I of this study makes use of existing information on hazardous wastes in the NWT to describe basic background on the hazardous waste situation in the NWT. It will also provide a definition of hazardous wastes and outline regulations pertaining to hazardous wastes in the NWT. Problems associated with solid waste management in the North will also be discussed.

CHAPTER 2

WHAT ARE HAZARDOUS WASTES ?

To avoid complete confusion it is necessary to explain what hazardous wastes are at this point. This is not an easy task. Almost every province uses a different definition for hazardous wastes. Currently the most commonly used definition is the one provided by the *Transportation of Dangerous Goods Act* (TDGA). Although this definition is suitable for regulatory purposes, it excludes several wastes which should be considered hazardous in the North.

2.1 "Hazardous" versus "Special"

The terminology used to describe high concern wastes is not common in every jurisdiction. Some regions use the term "hazardous wastes" while other use "special wastes".

The term "hazardous" may in some cases over-exaggerate the characteristics of some wastes. However, the public may feel that the term "special" is being used to disguise the harmful nature of a substance. In this study the term "hazardous" shall be used.

2.2 The Inclusion of Bulky Wastes

Bulky wastes are items such as used appliances, vehicles, oil drums and construction wastes. These wastes have the tendency of accumulating in northern, isolated communities where recycling is impractical because transportation costs are high. Bulky wastes are a high concern in the North and their disposal should be addressed in this study. Although in a true sense they cannot legitimately be considered "hazardous", for the purpose of this study, unless otherwise stated, the term "hazardous wastes" shall refer to both hazardous and bulky wastes.

2.3 Choosing a Definition

Finding a regulatory definition for hazardous wastes that will please everyone concerned is an impossible task. Some people believe that the only definition to use is the definition provided by the Transportation of Dangerous Goods Act (TDGA). Some believe that bagged sewage should be included because it is an infectious waste. Some feel waste oil should be included. Others disagree. For example, waste oil is classed as hazardous in B.C. but not in Ontario (Bryant, 1991). One must accept the fact that one common definition cannot satisfy everyone.

In this section two definitions will be described; one for regulatory purposes and the other for practical purposes. The TDGA definition was chosen as the regulatory definition because it is used throughout Canada. A separate working definition was developed specifically for this study to include most of the questionable wastes.

2.4 Regulatory Definition

A federal/provincial/industry cooperative effort has defined "hazardous waste" as those wastes which, due to their nature and quantity, are potentially hazardous to human health and/or the environment and which require special handling and disposal techniques to eliminate or reduce the hazard (Environment Canada, 1989).

TDGA regulations classify dangerous goods into 9 classes.

Class 1, Explosives, includes:

1.1 substances with a mass explosion hazard;

1.2 substances with a fragment projection hazard, but not a mass explosion hazard;

1.3 substances that have a fire hazard along with either a minor blast hazard or both, but not a mass explosion hazard;

1.4 substances that represent no significant hazard; and

1.5 very insensitive substances, although with a mass explosion hazard as in 1.1.

note: Explosives cannot be a waste by definition of the Explosives Act. Explosives are classified by Energy, Mines and Resources Canada.

Class 2, Gases, includes:

2.1 flammable gases;

2.2 non-flammable, non-toxic, non-corrosive gases;

2.3 poisonous gases; and

2.4 corrosive gases.

Class 3, Flammable Liquids, includes:

3.1 liquids with a closed-cup flash point of less than -18°C. These are extremely flammable;

3.2 liquids with a closed-cup flash point of not less than -18°C, but less than 23°C. These are very flammable; and

3.3 liquids with a closed-cup flash point not less than 23°C, but less than 37.8°C. For international air transport, the flash point is not less than 23°C, but less than 60.5°C. For waste and international marine transport, the flash point is not less than 23°C, but less than 61°C. These are moderately flammable.

Class 4, Flammable Solids, and Substances liable to Spontaneous Combustion, or that on contact with water emit Flammable Gases, includes:

4.1 solids which under normal circumstances are readily ignitable and burn persistently or, which cause or contribute to fire, through friction or from heat retained from manufacturing or processing;

4.2 substances liable to spontaneous combustion under normal conditions of transport, or, when in contact with air are liable to spontaneous heating to the point where they ignite; and

4.3 substances which, on contact with water, emit dangerous quantities of flammable gases, or become spontaneously combustible on contact with water or water vapour.

Class 5, Oxidizing Substances and Organic Peroxides, includes:

5.1 substances that cause or contribute to the combustion of other material by yielding oxygen or oxidizing substances, whether or not the substance itself is combustible; and

5.2 organic compounds that contain the bivalent "-O-O-" structure.

Class 6, Poisonous Substances and Infectious Substances, include:

6.1 solids or liquids that are poisonous through vapour inhalation, by skin contact, or by ingestion; and

6.2 organisms that are reasonably believed to be infectious to humans or animals, and the toxins of such organisms.

Class 7 comprises **Radioactive Materials** with activity greater than 74 kBq/kg, within the meaning of the Atomic Energy Control Act.

n.b. Radioactive materials cannot be a waste by definition of the Atomic Energy Control Act. Radioactive materials are classified by the Atomic Energy Control Board.

Class 8 comprises **Corrosive Substances** that cause visible necrosis of the skin, or that corrode steel or non-clad aluminum, or are wastes that have a pH factor less than 2.0 or greater than 12.5.

Class 9, Miscellaneous Dangerous Goods, includes:

9.1 substances or products that present sufficient danger to warrant regulation, but that cannot be assigned to another class;

9.2 environmentally hazardous substances; and

9.3 wastes that present sufficient danger to warrant regulation, but that cannot be assigned to any other class.

note: Class 9, miscellaneous dangerous goods, are classified and listed by Transport Canada and Environment Agencies only. If the concentration of the 9.2 contaminant is less than 100 ppm, the TDG Regulations do not apply.
(Environment Canada, 1989)

A proposed amendment to the TDG Regulations defines "waste dangerous goods" as products, substances, or organisms that are no longer used for their original purpose and that are recyclable material or are intended for treatment or disposal, or are stored prior to treatment or disposal. Waste dangerous goods do not include products, substances, or organisms that are household in origin, returned directly to the supplier for reprocessing, repackaging, or resale because they are defective or otherwise not usable, in surplus, or are included in Class 1 or 7 (Environment Canada, 1989).

For the purpose of this study the TDG Regulation's definition of hazardous waste cannot be used, or must be expanded on because in does not include:

- household hazardous wastes;
- used oil;
- bulky wastes;
- animal carcasses; and
- some biomedical wastes.

2.5 Working Definition

The following definition has been developed solely for this study. It divides hazardous wastes into seven categories. They are described as follows:

1. **Flammable** - Liquids or solids that can ignite (e.g. waste fuel, turpentine, paint thinner)
2. **Corrosive** - Substances that eat and wear away at many materials (e.g. vehicle battery acid, caustics, drain-cleaners)
3. **Reactive** - Materials that can create an explosion or produce toxic vapours (e.g. explosives, ammunition)
4. **Poisonous** - Substances that are poisonous or lethal (e.g. waste oil, mercury, cyanide, arsenic, pesticides, antifreeze)
5. **Infectious** - Materials that can cause disease (e.g. medical wastes, bagged sewage, sewage sludge, animal carcasses)
6. **Environmental Contaminants** - Materials which bioaccumulate and persist in nature (e.g. DDT, PCB's)

7. **Radioactive** - Substances which emit ionizing radiation or objects contaminated with particles which emit ionizing radiation (e.g. uranium, ionization type smoke alarms)

note: In the TDGA definition the category "toxic" includes both poisonous and infectious wastes.

This definition was adopted because it is simple, and includes all pertinent waste categories. Bulky wastes pose unique problems but cannot be called hazardous and are therefore not listed in this definition. Even so, as stated previously, they are included in this study.

Although industry must follow the TDGA definition for transportation and handling of hazardous goods, this study is concerned with wastes which could harm people or the environment, not only those included in a federal definition. Guidelines must be established for the proper disposal of such items even if they may not be federally regulated.

2.6 References

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Environment Canada, 1989. Transport of Hazardous Wastes, Question and Answer Manual. Beauregard Printers. Ottawa, Ont.

CHAPTER 3

LITERATURE REVIEW

This chapter discusses previously available information pertaining to hazardous wastes in the NWT. This literature review made the need for a hazardous waste inventory obvious. Literature available on the subject has been sketchy and/or dated. However, some practical information is present and may be useful for comparison purposes.

3.1 Literature Pertaining to Hazardous Wastes Generated in the NWT

The first hazardous waste inventory was done by W.L. Wardrop and Associates Ltd. in 1979. It identified 20 hazardous waste categories and found that of these, 9 were generated in significant quantities in the NWT. These quantities are given in Table 3-1.

The report "Hazardous Wastes in Northern and Western Canada" contained an inventory on hazardous wastes in that region (Reid, Crowther and Partners Limited, 1980). Quantities obtained from this study are compared to those found by Wardrop and Associates (1979) in Table 3-1. The 1980 inventory was prepared by a theoretical approach called the rate approach and contained information about hazardous wastes in the NWT.

To perform the rate approach, potential hazardous waste generating businesses were identified, their number of production employees assessed, and, using unit waste

TABLE 3-1
ESTIMATES OF HAZARDOUS WASTES GENERATED
IN THE NWT AS IDENTIFIED BY
WARDROP (1979) AND REID, CROWTHER AND PARTNERS LTD. (1980)

Substance	Quantity/yr Wardrop and Assoc. (1979)	Quantity/yr Environment Canada (1980)
Acid Solutions	3,200,000 L	5 L
Alkaline Solutions	8,912,000,000 L	35 L
Contaminated Soil and Sand	760,000 tonnes	0.005 tonnes
Oils	2,500,000 L	690 L
Drilling Mud	1,800 tonnes	---
Tetraethyl Lead Sludge	5,000 L	---
Aqueous Chemical Waste	32,000,000 L	---
Solid chemical Waste	36,000,000 L	---
Photo Wastes	50,000 L	---
Metal Bearing Sludge	---	0.09 tonnes
Paint	---	0.35 tonnes
Cyanides	---	0.003 tonnes
Non-halogenated Solvents	---	0.003 tonnes
Tank Bottoms	---	1.141 tonnes
Fly ash	---	0.001 tonnes
PCB's	---	0.001 tonnes

Source: Stanley Associates Engineering Ltd., 1986.

generation rates for specific industry sectors, total waste generation rates were estimated. The accuracy of the data was greatest at the general level; the data became less accurate when applied to more localized situations. It must be noted that this inventory was prepared in order to evaluate the amount of waste which would be available for a central treatment facility. With this in view, mining wastes were not included since they are generally handled on site. Since mining is one of the largest industries in the territories, exclusion of these wastes substantially affects the totals and consequently one must be cautious when drawing conclusions from this data.

The inventory identified four producers of hazardous waste in the territories:

- 1 machine shop with 5 production employees;
- 1 ship building and repair shop with 80 production employees;
- 1 dry cleaner with 5 production employees; and
- 1 hospital with 431 beds.

It is now obvious that the survey was not very thorough, regarding hazardous wastes in the NWT. Such estimates are of little value when today in the NWT there are:

- 8 machine shops;
- 7 ship building and repair shops;
- 6 dry cleaners; and
- 5 hospitals (Orion Data and Communications, 1990).

The study (Reid, Crowther and Partners Limited, 1980) also neglected to include such other diverse potential hazardous waste generators as oil and gas exploration, photo-finishing and funeral services.

It must also be noted that the 1980 report was not specific to the NWT but also included the Yukon, British Columbia, Alberta, Saskatchewan, Manitoba and Northwestern Ontario. Therefore, the amount of waste generated in the NWT (population approximately 50,000) was in most cases considered negligible. The small values obtained in this study can be attributed to the fact that the 1980 inventory was not specific to NWT and consequently there was some lack of accuracy in estimating quantities generated by a relatively small percentage of the population.

In 1984 Environment Canada published a report called "Study to Develop a Uniform Strategy for Handling Solid Wastes in the Beaufort Region" (Lavalin, 1984). The following are communities which were considered to be in "The Beaufort Region" for this report:

Aklavik	Hay River
Arctic Red River	Inuvik
Coppermine	Jean Marie River
Fort Good Hope	Norman Wells
Fort McPherson	Paulatuk
Fort Norman	Tuktoyaktuk
Fort Providence	Wrigley
Fort Simpson	

It was found that in the Beaufort region, generation of industrial waste (2.3 - 6.1 kg/cap/day) was approximately twice the municipal solid waste generation rate (1 - 1.6 kg/cap/day). The characteristics of industrial waste are largely unknown but it can be assumed that a sizable portion of them may be hazardous.

The 1984 paper stated that a considerable fraction of the industrial waste generated consists of drilling mud. Approximately 1,500 m^3 of drilling mud is produced to drill a 4,000 m deep well. It was estimated in the report that between 1987 and 2000, 655 wells may be drilled in the Beaufort Region. This would generate almost a million cubic metres of drilling mud.

Aside from that, the report did not quantify hazardous wastes, but it did describe some currently used disposal techniques. For example, in Norman Wells, wastes are treated as follows:

- drilling mud is collected in a sump where the water is evaporated. The remaining sludge is land farmed;
- chemicals are stored in a diked yard;
- liquid wastes are injected into a deep well; and
- unrefillable drums are crushed and shipped south.

In Tuktoyaktuk:

- waste oils are generally flared off, or incinerated; and
- chemicals are usually stockpiled and exported south in the fall.

This report discussed the need for an:

> "Accurate and complete inventory of hazardous wastes in the Beaufort Region...before the problem of disposal in the region can be overcome...Until the problem is better defined, however, alternatives cannot be considered."
> (Lavalin Engineers Inc., 1984)

The impact of mining wastes on the environment was stressed in "Waste management in the North: A Discussion Paper" (Stanley Associates Engineering Ltd.,1986). It stated:

> "The disposal of mine tailings and associated environmental problems are considered to overshadow those associated with disposal of small quantities of other wastes such as oils, maintenance and office wastes...Specific concern is given to the disposal of process and by product chemicals such as arsenic trioxide and sodium cyanate."

The characteristics of wastes produced by offshore oil and gas production were outlined. Hazardous wastes at Canadian DEW-Line sites were also mentioned.

One part of the study (Stanley Associates Engineering Ltd., 1986) involved interviews with key personnel in Ottawa, Yellowknife, Whitehorse and Alaska to assess how legislation was applied, and to determine waste management issues. Of particular interest were the waste management issues which the respondents identified. They were as follows:

- industry participation in the drafting of regulations;
- transfer of regulatory responsibility from federal to territorial governments;
- clean-up of PCB's at DEW-Line sites;
- remedial measures at abandoned mine sites.
- oil-based drilling muds;
- off-shore exploration wastes;
- solid waste from exploration camps;
- consistency and coordination among various levels of government;
- development of a waste management strategy;
- identification of sites for metal disposal;
- too many regulations;
- overall policy for identification procedures for land disposal or burial of specific wastes;
- mining waste research needed in Eastern Arctic; and
- amendments to Northern Inland Waters Act.

One of the recommendations of this report was to "Develop Waste Management Inventory and Tracking." It stated:

> "There is a wide variety of hazardous or toxic waste management issues to be addressed in the North. In order to identify and implement strategies in an expeditious manner, waste generation needs to be priorized, quantified and located... A new inventory based on a rigorous definition of wastes, government record, industry cooperation, contacts with potential information sources, site investigations and a review of appropriate reports and literature."

In 1987, the Department of Renewable Resources commissioned a telephone survey on used oil generated by businesses and industries in the western service area of the NWT (Stanley Associates Engineering Ltd., 1987). The Western service area was defined as the section of the NWT serviced by the highway or barge system.

Emphasis of the survey was placed on larger producers of waste oil and contaminated fuels, such as Northern Canada Power Commission (NCPC), the major barge companies, the various levels of government, mines, airlines and oil companies. However, a considerable number of smaller companies engaged in trucking, construction, fuel distribution and vehicle service were also contacted.

Of the 22 companies surveyed, 13 indicated that some of their waste oil could be made available for recycling. This represented about 67% of the total waste oil generated by the surveyed companies. It was found that the smaller establishments used a significant quantity of their oil for dust suppression and heating. Seventeen percent of all used oil was reported to be used for heating and it was estimated that 20% was used for dust suppression.

In 1989 an update of this survey was done (Stanley Associates Engineering, 1990b). The survey was performed in the same manner as in 1987. The results of these surveys are shown in Tables 3-2 and 3-3. This survey also attempted to obtain a more detailed evaluation of disposal methods.

Unfortunately only about half of the respondents specified this. The results are given in Table 3-4.

TABLE 3-2
DEVELOPMENT OF WASTE OIL QUANTITIES
BY PRODUCING CATEGORY

Category	Quantity 1987 (L)	Quantity 1989 (L)	percent change
Marine Transport	249,000	27,300	- 89%
Air Transport	37,800	15,300	- 60%
Industries			
- mining	132,600	255,000	+ 92%
- oil and gas	57,200	408,434	+ 614%
Public services	194,800	130,720	- 33%
Vehicles (1)	977,100	777,438	- 20%
Miscellaneous (2)	---	35,230	
Totals	**1,648,500**	**1,649,421**	**0%**

Notes:
(1) The "vehicles" category combines the construction, long distance and local vehicles categories from the 1987 report. The three subcategories have been reorganized from the 1989 report and include construction, commercial, and personal/small vehicles.
(2) The miscellaneous category is new in the 1989 report. The waste oil covered by this quantity was included in the construction and vehicle categories in the 1987 report.
Source: Stanley Associates Engineering Ltd., 1990b.

TABLE 3-3
DEVELOPMENT OF CONTAMINATED FUEL QUANTITIES
BY PRODUCING CATEGORY

Category	Quantities 1987 (L)	Quantities 1989 (L)	percent change
Marine Transport	119,500	45,000	- 62%
Air Transport	5,580	---	- 100%
Industries;			
- includes bulk fuel plants	27,500	38,900	+ 41%
- oil and gas	---	---	
Public Services	---	---	
Vehicles	3,600	---	- 100%
Miscellaneous	---	---	
Totals	**156,180**	**83,900**	**- 46%**

Source: Stanley Associates Engineering Ltd., 1990b.

TABLE 3-4
WASTE OIL IN THE NWT
SUMMARY BY DISPOSAL METHOD
QUANTITIES IN L/year

Category	Shipped South	Fuel	Flared	Stored	Dust Control	Land-Filled	Fire Practice	Not Specified
Marine Transport	15,000		12,300					
Air Transport		65,600		1,500	2,250			11,550
Industry	55,000	47,100	342,834		120,000		10,000	70,000
Services		33,000	900	10,590		2,300	20,000	49,830
Vehicles	39,000			4,000		14,600	60,000	626,838
Misc.								35,229
Totals	**109,000**	**145,700**	**356,034**	**16,090**	**122,250**	**16,900**	**90,000**	**793,447**
Percent (%)	7	9	22	1	7	1	5	48

Source: Stanley Associates Engineering Ltd., 1990b.

3.2 Literature Pertaining to Hazardous Waste at Landfills in the NWT

A 1982 report identified 432 active and inactive disposal sites in the NWT, and priorized them into one of three categories (Underwood, McLellan and Associates, 1982). Each site was evaluated using twenty parameters and assigned a point value. A high score was an indication of potentially hazardous and undesirable disposal site conditions. The best and worst obtainable scores were 12 and 315 respectively. Of the 235 disposal sites that had sufficient information to be assigned a point rating:

- 20 were classified as Priority 1 (extremely hazardous and undesirable sites) with scores ranging from 167-204;
- 67 were classified as Priority 2 (moderately hazardous and undesirable sites) with scores ranging from 135-169; and

- 110 were classified as priority 3 (adequate sites) with scores ranging from 70-134.

Hazardous wastes identified at the sites included:

- clinical wastes;
- industrial wastes;
- research centre wastes;
- bagged sewage (honey bag wastes);
- PCB's;
- oil; and
- petro-chemical by products.

This study was very thorough, although most of the information was obtained solely from literature, reports and personal communication. Very few, if any, site inspections were performed.

In 1985, Indian and Northern Affairs Canada commissioned a study of inactive hardrock mine sites in the Yukon and NWT (Boojum Research Ltd., 1985). The study investigated 21 sites which had been inactive since 1983. All the mines were associated with a mill and therefore produced tailings. Environmental data was obtained from mining journals, mining company reports, government reports and personal communication with mine operators. Environmental components considered relevant to the determination of contamination were:

- tailings;
- water; and
- sediments from nearby water bodies.

Arsenic and lead concentrations in tailings were found to differ only marginally from that of the host rock. Cyanide at inactive sites was in the form of cyano-metal complexes and was not considered an environmental concern. Mercury, from amalgamation, was found in tailings at all sites at various concentrations. Elevated concentrations posed a threat to human health and could cause severe environmental degradation.

In 1985 the Environmental Protection Service (EPS) produced three unpublished reports on the Yellowknife, Norman Wells and Hay River municipal landfill sites (Environmental Protection Service, 1985). The reports were based on visual inspection and testing performed at the sites.

Hazardous wastes identified at the Yellowknife dump were as follows:

- dead animals;
- batteries;
- chemical drums;
- bulky wastes;
- 50 drums from aviation fuel;
- paint cans;
- aircraft de-icing fluid drums;
- ethylene glycol drums;
- pentachlorophenol drums (wood preservative); and
- empty isopropanol drums.

From tests done in the area, it was concluded that "It does not appear that significant concentrations are accumulating in the leachate or receiving waters." (Environmental Protection Service, 1985)

Hazardous Wastes identified at the Norman Wells Dump were as follows:

- paint cans;
- batteries;
- petroleum product cans and barrels;
- Johnson step-Off(monoethanolamine);
- Johnson Forward(N-Alky,dimethyBenzyl Ammonium Chlorides, Anhydrous Sodium Metasilicate);
- epoxy (Butylglycidyl ether); and
- bulky wastes.

Hazardous wastes identified at the Hay River Dump were;

- 65 drums of potassium chloride(used as a fire extinguishing agent)
- 10 drums of Dowper(stabilized perchloroethylene);
- paint;
- oil drums; and
- ethylene glycol.

A recent solid waste management study done for the City of Yellowknife made no mention of hazardous materials (Stanley Associates Engineering Ltd., 1990a).

In 1989 a survey was conducted by Heinke and Wong on solid waste collection and disposal in communities in the NWT (Heinke and Wong, 1990). Although the survey did not concentrate on hazardous wastes, some of the information obtained from the survey was applicable to this study. Of particular interest were responses to these questions:

- If honey bags are used, are they disposed of separately from solid wastes?
- Are bulky wastes/metal wastes disposed of separately from solid wastes?
- Are used oil wastes disposed of separately from domestic wastes?
- In your opinion, should used oil be disposed of separately?
- How do you currently disposed of used oil?
- Is the disposal of hazardous or toxic wastes (for example, PCB's) a problem in your community?

The results of this survey demonstrated that hazardous wastes were not clearly understood. Communities were unaware that many everyday substances are hazardous if used or disposed of improperly. Of all the communities responding, only three felt that there was a problem with hazardous wastes in their community. Clearly, this indicates a lack of knowledge or concern about the topic rather than sound management of hazardous wastes.

The survey did reveal that there was some concern for proper disposal of honey bag and bulky wastes. Of the communities responding, 89 % provided separate honey bag waste and 76 % provided bulky waste areas. Waste oil was disposed of separately in 58% of communities responding. This oil was either burned, used to burn garbage, stored in drums or dumped (Heinke and Wong, 1990).

3.3 References

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CHAPTER 4

OVERVIEW OF HAZARDOUS WASTES IN THE NWT

This chapter summarizes information on types and sources of hazardous wastes in the NWT, as obtained from literature review and personal communication. It is intended to give the reader background information on the past and present situation.

The overview will be divided into three sections covering:

- hazardous wastes accumulated in the NWT;
- dangerous goods transported in the NWT; and
- hazardous wastes generated in the NWT.

4.1 Hazardous Wastes Accumulated in the NWT

As previously mentioned, hazardous wastes have been accumulating in the NWT since the first exploration by Europeans. Soon after, permanent settlements were built requiring fuel oil, building supplies, machinery and household goods. This generated hazardous wastes, bulky wastes, and household garbage. Modern technology brought non-degradable items into the North but did not provide a means of proper disposal.

The introduction of mining and oil industries brought unique wastes into the region. Many military sites and DEW-line (Distant Early Warning sites) were built, and later abandoned, leaving hazardous materials improperly stored and unattended. There have been over 500 abandoned waste sites identified throughout the NWT (Bryant, 1991).

Military sites

There are currently 58 military sites in the NWT. Of these sites, 24 are abandoned. All these sites were built by the United States government but some are used by the Canadian Department of National Defense. All abandoned sites were left susceptible to vandalism and natural decay (Holtz et al., 1986, and Stanley Associates Engineering Ltd.,1986).

Examination of the sites in 1985 (Holtz et al.,1986) confirmed the presence of:

- metal and wood debris;
- electrical equipment (much of which contained PCB liquid);
- empty or partially filled drums of diesel fuel;
- petroleum and oil tanks (some with their original contents, some leaking);
- lubricating oils; and
- solvents.

Moderately elevated levels of PCB's were found in soil samples at several of these sites. Many buildings had been demolished by local people scavenging items of value for personal use. Hazardous materials found at these sites are listed in Table 4-1.

During the 1985 clean-up of 21 abandoned DEW-Line sites and 1 Coast Guard site, approximately 7,300 kg of the

TABLE 4-1
HAZARDOUS MATERIALS AT ABANDONED MILITARY SITES

waste oil	mercury vapour
rectifier tubes	PCB transformers
asbestos	PCB capacitors
sewage	batteries
lead-based paints	chlorinated hydrocarbons
rubidium radio tubes	corrosion inhibitors
radar components	lye
fuel drums	corrosives
antifreeze	solvents
aviation fuel	dynamite
sulphuric acid	RF interference filters
transmission fluid	asbestos covered piping
1-1-1-trichloroethane	gas cylinders
paint thinners	

Source: Holtz et al., 1986 and Envirochem Special Projects Ltd.,1990.

estimated 10,000 kg of PCB contaminated liquid were removed. Five hundred and forty drums of varsol, lube oil, diesel and aviation fuel were located on these sites and contained or burned. Tests performed on soil at the communications site in Cape Christian revealed diesel fuel levels of 74,000 mg/kg soil in some locations. This was almost 200 times higher than background level (43 mg/kg soil) (Envirochem Special Projects Inc., 1990).

The greatest concern to human health and safety comes as a by-product of scavenging. Many of these locations are remote; however, there was evidence of recent use by people hunting and/or fishing at some sites. In some places, not all PCB containing equipment is accounted for. During the clean-up of the Keith Bay Site (Cam E) missing electrical equipment was found in the nearby community of Pelly Bay.

The site at Iqaluit has been so heavily scavenged that even one of the buildings was removed from the site for use elsewhere (Collings, 1990).

Another potential hazard is associated with contamination of fish and animals. Some sites are visited by wildlife species such as caribou, hawks, falcons, geese, swans and sandhill cranes (Holtz et al., 1986). PCB's, possibly originating from these sites, have been found in arctic marine wildlife (e.g. beluga whale and narwhal blubber and fish) in a number of locations across the Arctic. Lower concentrations have also been found in terrestrial animals such as caribou, furbearers and birds. This is of particular concern, as many native diets include a high proportion of wild game (Environment Canada, 1990).

One initiative being proposed under the federal "Green Plan" is that Environment Canada clean up all hazardous wastes at abandoned military and DEW-Line sites (Bryant, 1991).

Abandoned Mines

One of the incentives for northern development was and still is the search for minerals. Commodities which have been mined in the NWT are listed in Table 4-2.

TABLE 4-2
MINERALS PRODUCED IN THE NWT

gold	zinc
silver	tungsten
uranium	copper
lithium	lead

Source: Cunningham, 1990.

Of the 46 currently inactive mine disposal sites in the NWT over 20 of these consist of unreclaimed, contaminated mine tailing deposits (Underwood, McLellan and Associates, 1982). Potential hazards associated with inactive tailings ponds, identified by Underwood, McLellan and Associates, 1982 and Johnston, 1990 are:

- acid generation from breakdown of sulphide minerals;
- leaching and mobilization of metals (e.g. mercury, arsenic, lead, copper and radionuclides);
- wind and water erosion of fine tailings into water bodies resulting in the release of metals;
- bioaccumulation of selected metals (e.g. mercury) in wildlife; and
- possible contamination by cyanide complexes and/or PCB's.

Mercury from the amalgamation process is evident in tailings at various concentrations. PCB's have also been identified and contained at several inactive mine disposal sites (Boojum Research Ltd., 1985).

Tests performed on several lakes in the vicinity of inactive tailings ponds (Hall and Sutherland, 1989) revealed high levels of copper, lead, mercury and other heavy metals, and relatively high radium 226 activity. Two examples are:

a) Discovery Mine, near Yellowknife; and

b) Rankin Inlet Nickel Mine in Rankin Inlet.

a) Discovery Mine

Discovery is a gold mine on Giauque Lake, approximately 75 km north east of Yellowknife. It operated from 1950 - 1969 using mercury amalgamation and cyanation techniques and produced about 1,100,000 tonnes of tailings during that period

(Hall and Sutherland, 1989).

The relatively large abandoned deposit at Discovery is actively eroding into the adjacent lake. Mercury has accumulated in the fish of Giauque Lake beyond acceptable limits for human consumption. (Johnston, 1990)

b) North Rankin Inlet Nickel Mine

This nickel mine operated from 1957 until 1962, when the mineral reserves were depleted. (Underwood, McLellan and Associates, 1982) It lies partially within the municipal boundaries of the Hamlet of Rankin Inlet. Recent studies revealed that a substantial area, where the town was considering construction of a new subdivision, was contaminated with arsenic. Because of this discovery Fisheries and Oceans Canada is currently testing mussels in the area for contamination (Stephenson, 1990). Before the introduction of the federal "Green Plan", Indian and Northern Affairs Canada was responsible for the clean-up of all known hazardous wastes on Crown lands in the NWT. Under this new program the clean-up falls under Environment Canada (Bryant, 1991).

Hazardous Wastes Accumulated in Communities

Due to the terrain, climate, long distances and lack of infrastructure, transportation in the NWT is expensive. Consequently, hazardous wastes tend to accumulate in remote regions. Most items brought into communities have never been removed.

Items such as oil drums, old vehicles, appliances and car batteries litter northern communities and consume tremendous amounts of space in dumps. Oil was once brought into communities in drums. The empty drums were either used for garbage containers or discarded. Now, each community has a tank farm where oil is delivered. This has stopped most of the generation of empty drums but those which had previously accumulated have not yet been removed.

Additional hazardous wastes which have accumulated in dump sites themselves are:

- bagged sewage (honey bags);
- biomedical wastes;
- batteries;
- solvents;
- paints;
- gas cylinders; and
- other household hazardous wastes.

4.2 Dangerous Goods Transported in the NWT

Table 4-3 lists dangerous goods which are known to be transported in the NWT. These materials are either consumed in the NWT, transported out of the territories or become a hazardous waste to be disposed of in the NWT. Records are currently not kept on their disposal methods. Since there are currently no hazardous waste disposal facilities in the North, it can be assumed that a significant portion of the waste is indiscriminately dumped into landfills or sewers.

TABLE 4-3
DANGEROUS GOODS TRANSPORTED IN THE NWT

Argon	Lead Nitrate
* Acetylene	Liquified Petroleum Gas
Adhesive	Methanol
Ammonium	Naphthalene
Ammonium Nitrate	Nitric Acid
Arsenic Trioxide	Nitrogen
* Aviation Fuel	* Oxygen
Batteries	Paints and Paint related Materials
Battery Fluid	PCB's
Calcium Chlorate	Phosphoric Acid
* Calcium Chloride Solution	Potassium Hydroxide Soln.
Calcium Oxide	Propanol
Chlorine	Radioactive Material
Dibenzoyl Peroxide	Resin Solution
* Explosives	Sodium Borohydride
* Fuel Oil	Sodium Metal Dispersion
* Gasoline	Sodium Nitrate
Hypochloride solutions	Sodium Potassium Cyanide
Hydrogen Peroxide	
Hydrochloric Acid	

Source: Kearns, 1990

* indicates most frequently transported in the NWT

4.3 Hazardous Wastes Generated in the NWT

> "Hazardous wastes are produced by all countries, irrespective of their state of development. Examples of such ubiquitous wastes might include oils from transportation, redundant pesticides from agriculture, hospital wastes, waste from ship cleaning, chemical wastes from commerce, mercury from fluorescent lamps and batteries, acids and lead from recycling of motor batteries."
> (Wilson and Balkau, 1990)

As industrial development proceeds, hazardous wastes are produced from industries such as metal mining and processing and oil extraction and refining. This section is intended to describe the hazardous wastes generated in the NWT and the activities which produce these wastes.

Hazardous Wastes Generated by Industrial Activity

Industry in the NWT can be divided into two main groups:

a) mining; and

b) oil and gas exploration.

In most cases, these industries because of their remote locations, act as industries and small industrial communities or work camps. Thus, they generate both industrial and domestic wastes.

A 1984 report on solid wastes in the Beaufort region (Lavalin Engineers Inc., 1984) used a municipal type solid waste generation rate of 3.64 kg/cap/day. This figure was estimated by the Task Force on Northern Oil Development in 1973. In 1982 Dome Petroleum estimated that an additional 4.66 kg/cap/day of solid wastes are generated in the course of industrial operations (bulk storage/staging, warehousing shops, airport, and dock). The Beaufort region report concluded that solid waste from a support base could amount to about 8.3 kg/cap/day.

a) Mining Industries

There are 6 mining companies currently operating in the NWT producing primarily lead, zinc, gold and silver. (Orion Data and Communications, 1990) The primary hazardous wastes generated are listed in Table 4-4.

TABLE 4-4
PRIMARY HAZARDOUS WASTES GENERATED AT MINES

Acid Solutions	Spent Solvents
Alkali Solutions	Tank Sludges
Contaminated Soil and Sand	Wastes Associated with Equipment Repair
Drilling Mud	Wastes Associated with Construction
Explosives	
Oils	

Source: Reid, Crowther and Partners Limited, 1980 and Thompson, 1990.

Wastes associated with equipment repair include:

- waste oil;
- acid batteries;
- antifreeze;
- cutting oil; and
- bulky wastes.

Wastes associated with building maintenance and construction include:

- resins;
- adhesives;
- paints;
- paint thinners;
- strippers and lacquers; and
- bulky wastes.

Many mining wastes are placed in on-site disposal areas called tailings ponds. The treatment accomplished in tailings ponds includes:

- gravity settling;
- chemical oxidation or reduction; and
- ultraviolet breakdown of solids and liquids.

Wastes treated in this manner are usually acids, alkalis, contaminated soil and sand, and drilling muds.

Other wastes are often treated in the following manner:

- obsolete explosives are detonated with fresh material in the extraction of ore stage;

- used oil and spent solvents are either burnt or used for dust control; and
- many other wastes are stored on site or disposed of at an on-site landfill.

b) Oil and Gas Exploration

There are four oil and gas companies operating in the NWT. They operate in the Beaufort Sea, Mackenzie Delta, and the Mackenzie River at Norman Wells. (Orion Data and Communications, 1990) The predominant wastes are listed in Table 4-5.

TABLE 4-5
HAZARDOUS WASTES PRODUCED BY OIL AND GAS EXPLORATION

Waste drilling fluid	Glycol
Acid Water	Catalysts
Alkaline Solution	Wastes from equipment Repair and Maintenance
Waste Oil Sludge	Waste from building repair and maintenance
Treater Hay	
Filters	
Oil Spill Debris	

Source: Stanley Associates Engineering Ltd., 1986, Reid Crowther and Partners Ltd., 1980 and Canadian Petroleum Association, 1984.

Drilling mud is generated in a larger quantity than the rest of these wastes. (Lavalin Engineers Inc., 1984) It is needed in the drilling system to flush away broken rock, lubricate the bit, and maintain pressure that prevents fluids in the rock formation from flowing. Drilling muds are generally either discharged into receiving bodies or collected in a sump, where the water evaporates. The remaining sludge is land farmed.

Treatment methods used for other wastes include:

- Waste oil sludge, recycled or treated to remove soil and sand, spread on roadways or burnt off;
- Filters, burnt or disposed of in landfill sites; and
- Other wastes, generally taken to on-site or municipal landfill sites.

Hazardous Wastes Generated by Businesses

Businesses which generate substantial quantities of hazardous wastes in the NWT can be grouped into 5 categories:

a) vehicle and equipment repair, transportation and cartage;

b) building construction, repair and maintenance;

c) manufacturing and fabrication;

d) printing, publishing and photo finishing; and

e) dry cleaning.

a) Vehicle and Equipment Repair, Transportation and Cartage

This group includes more businesses than any of the others. Hazardous Wastes generated by these facilities are listed in Table 4-6.

TABLE 4-6
HAZARDOUS WASTES PRODUCED BY VEHICLE AND EQUIPMENT REPAIR, TRANSPORTATION AND CARTAGE

waste oil	fuel tank sludges
spent solvents	acid batteries
waste paint	anti-freeze
paint thinner	windshield washer fluid
contaminated fuels	resins and adhesives

Source: Stanley Associates Engineering, 1986, Reid, Crowther and Partners Limited, 1980, Technology Resources Inc.,1989 and

These wastes may be produced in small quantities by each generator but are substantial, collectively. Most of these wastes are either spread on roadways, burned off or dumped into municipal sewers, landfill sites or elsewhere.

b) Building and Road Construction, Renovation and Maintenance

This group includes businesses involved with construction, lumber, painting, and glass, wood and concrete products. This is the next largest group. Their wastes are listed in Table 4-7. Most of these wastes are disposed of in municipal sewers and landfill sites.

TABLE 4-7
HAZARDOUS WASTES PRODUCED BY BUILDING AND ROAD CONSTRUCTION, RENOVATION AND MAINTENANCE

waste paint	resins and adhesives
waste paint thinner	waste tar and residues
primers and sealers	asbestos
strippers and lacquers	cutting oil
spent solvents	wood preservatives

Source: Reid, Crowther and Partners Limited, 1980, Technology Resources Inc.,1989 and Alaska Department of Environmental Conservation,1986.

c) Manufacturing

This group consists of metal fabrication, machine shops, and ship and boat building. There are currently only about a dozen businesses of this type in the NWT. Wastes produced by this category include:

- waste paints and paint thinner;
- spent solvents;

- machining wastes;
- cutting oil;
- resins and adhesives; and
- metal finishing solutions.

Most of these wastes are disposed of in municipal sewers and landfill sites or private landfills (Reid, Crowther and Partners Limited, 1980, and Technology Resources Inc., 1989).

d) Printing, Publishing and Photo Finishing

These businesses produce a wide range of toxic by-products (Deyle, 1989). Printing and publishing wastes include:

- spent solvents;
- ammonia for blue print machines;
- copy machine chemicals;
- waste ink; and
- ink sludge.

Photo-finishing generates:

- waste fixers;
- waste developers
- ferricyanide bleach; and
- bleach-fix solutions.

These waste solutions and sludges may contain silver and are sometimes recycled to recover this metal (Alaska Department of Environmental Conservation, 1986). Their chemicals are toxic. If not recovered or reused photo-finishing wastes generally end up in municipal sewers or landfills.

e) Dry Cleaning

There are four commonly used substances in the dry cleaning business (Deyle, 1989, and Technology Resources Inc., 1989):

- perchloroethylene (PERC);
- DOW 611;
- petroleum solvent (Stoddard Solvent); and
- valciene (fluorocarbon 13).

PERC is harmful to the liver and kidneys in humans if swallowed. It may also be carcinogenic. Used petroleum solvents can cause nausea, vomiting, coughing and lung irritation. (see Appendix B for details)

Hazardous wastes generated by the dry cleaning industry, irrespective of the solvent used, include (Technology Resources Inc., Deyle, 1989, and Raymond, 1990):

- waste solvent;
- still residues;
- spent filter cartridges;
- cooked powder residues;
- drained filter residues; and
- oil and grease sludge contaminated with heavy metals.

Most operations are equipped with stills to recover cleaning solvents. Very small plants without stills probably discharge waste solvent directly to the sewer (Technology Resources Inc.,1989). The still residues and solvent filtration cartridges contain small fractions of solvent as well as waste grease, oil and dirt. Most solid residues and cartridges are picked up by the local garbage disposal and are landfilled. Sometimes these wastes are taken out of the Territories for proper disposal.

Hazardous Wastes Generated by Community Activity

Hazardous wastes are generated, in small quantities, by routine community activity. Activities which generate hazardous wastes in communities include:

a) building construction and road maintenance;

b) vehicle and equipment repair and maintenance;

c) education;

d) health and dental care;

e) power production and communication; and

f) household activities.

Wastes generated by **a) building construction and road maintenance** and **b) vehicle and equipment repair and maintenance** are listed in Table 4.6 and Table 4.7. Disposal methods used by communities for these wastes are similar to those described for businesses.

A recent study (Heinke and Wong, 1990) revealed domestic waste generation rates of 0.013-0.015 m^3/person/day of uncompacted wastes in the three communities studied. If construction activities are substantial in a community these rates can be as high as 0.017 m^3/person/day.

c) Education

Secondary and post-secondary educational institutions often incorporate chemical laboratories which may contribute to the hazardous waste problem. Most labs store a large variety of toxic substances which must eventually be disposed of, used or unused.

Other wastes produced by educational facilities are biological wastes, photo-finishing wastes, cleaning solvents and solutions and wastes involved with machine, auto body, and carpentry shops. In general, these substances end up in sewers, landfills or are stored on site indefinitely.

d) Health and Dental Care

This group includes nursing stations, hospitals, dental clinics, veterinary clinics and funeral services (Reid, Crowther and Partners Limited, 1980, Thompson, 1990, and Carpenter, 1990). These facilities generate a variety of infectious or otherwise toxic wastes including:

- disposables used in medical practice;
- anatomical wastes;
- sharps;
- out of date medication;
- discarded mercury thermometers;
- X-Ray developing fluid;
- disinfectants;
- waste formaldehyde; and
- animal carcasses.

The carcasses of euthanized animals are of particular concern. Not only could a carcass be carrying a disease but could also contain significant quantities of a deadly drug. If improperly disposed of, animals or birds may feed on the carcass and be harmed.

e) Power Production and Communication

Since power in the NWT is supplied by both hydroelectric and diesel generators, the wastes include:

- contaminated fuel;
- fuel tank bottoms;
- used oil;
- maintenance chemicals.
- asbestos;
- mercury;
- PCB's
- empty gas cylinders;
- acid batteries; and
- flammable wastes.

(Reid, Crowther and Partners Limited, 1980 and Helfrick, 1990)

f) Household Activities

The largest quantity of hazardous wastes generated in households of the NWT is human sewage. Many communities are serviced with bagged sewage (honey bags) or pump-out sewage systems. Some of these communities do not have adequate methods of disposing of these wastes. In some cases, honey bags and pump-out sewage are merely discarded in the landfill site. Few dumps in the Arctic are free from human and animal scavenging. The health hazards of this situation are evident.

Other household hazardous wastes are produced in any developed region (Environment Canada, 1988). They include:

- household cleaners;
- pesticides;
- herbicides;
- expired phamaceuticals;
- drain and oven cleaners;
- paints and paint thinners;
- nail polish remover;
- bleach;
- lighter fluid;
- hair spray;
- shoe polish;
- glues;
- bulky wastes; and
- various other wastes.

In most cases, these wastes end up in landfills, metal dumps or sewers.

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CHAPTER 5

OVERVIEW OF WASTE MANAGEMENT IN THE NWT

Solid waste management is faced with increasing difficulties in the North. Extreme climate and geography, isolation and small population centres make many waste management options impossible or at best, very expensive to implement. This chapter will summarize these problems and take a brief look at solid waste management practices presently used in the NWT.

5.1 Problems Associated with Climate and Geography

Many people from the South have a picture of the pristine, untouched North. They are unaware of the difficulties associated with delivery of normal municipal services in such an "exotic" land. Long winters, permafrost and an abundance of exposed bedrock limit the available waste disposal options.

Long Winters

The <u>Cold Climate Utilities Manual</u> (Smith et al.,1986) states: "At break-up, melting snow and ice reveal the accumulation of refuse during the winter." As one Iqaluit resident said, "For two months of the year everyone feels very guilty, but once the snow falls, everyone forgets."

Long periods of extreme cold make collection operations difficult, and vehicles expensive and difficult to use and maintain. Garbage dumps are hard to operate when often the only accessible cover material is snow (World Health Organization, 1985).

Many communities participate in annual spring clean-ups (Smith et al., 1986, Gerein, 1980, Heinke and Wong, 1990a, and Reindeer, 1990). Spring clean-ups are losing popularity in some hamlets because some people expect to be paid for time spent at community work. Spring, 1990, the hamlet of Fort Norman recruited school children for the clean-up and rewarded them with a donation to the school.

Permafrost

Much of the NWT is in a situation of discontinuous or continuous permafrost. There are several problems associated with operating a sanitary landfill in permafrost regions (World Health Organization, 1985). Some of these problems are that:

- disruption of the thermal regime will result in melting and slumping of ice-rich and/or fine grained soils;
- low temperatures do not permit the degradation of putrescible matter to occur, but merely place the waste in cold storage;
- excavation can be extremely difficult and may cause the destruction of the insulating layer; and
- problems arise in treating wastes by shredding because placement of shredded waste causes a disruption of surface material, resulting in deeper thawing of permafrost.

An additional problem in permafrost regions is the handling and disposal of sewage. An underground piped sewage system is expensive and may result in the melting of permafrost. Above ground sewage utilidor systems are expensive, require bridges or tunnels at road crossings and are susceptible to vandalism. In spite of these shortcomings, utilidors and piped systems are currently used totally or in part in 13 communities in the NWT. Water is distributed by trucked water systems, wells or hand-carry in the rest of the communities and the sewage system used is pump-out or bagged sewage, septic tanks or outdoor pit privies.

A pump-out sewage system consists of an insulated holding tank for sewage which is regularly pumped out to a collection truck, which delivers the sewage to a sewage lagoon or holding pond. In a few communities, pump-out sewage is disposed of along with municipal solid wastes. Bagged sewage systems employ a bucket toilet, lined with a plastic bag. These honey bags are collected regularly by the municipality. These services have a low capital cost but high operations and maintenance costs.

Disposal of honey bag and pump-out sewage is a major problem of this system. There is no convenient way of dealing with bagged sewage. It is cumbersome, inconvenient and unsanitary. Guidelines (Heinke and Wong, 1990a) suggest that it should be collected separately from solid waste and disposed of in a marked location away from the solid waste dump. It is the policy of the GNWT to reduce and eventually eliminate the use of bagged sewage.

Additional Concerns

Other additional problems with landfills in the North are:

- lack of cover material;
- windy situations; and
- difficulty in building fences.

For proper operation of a sanitary landfill site, adequate cover material is essential. An ideal location for a waste disposal site has been described (Lapp, 1985) as having these characteristics:

- fine textured soils such as clays, silts or tills should be present;
- sand and gravel areas are to be avoided;
- rocky areas are unusable;
- soil thickness of 10 m or more is desirable; and
- flat, well drained land is necessary.

Few of the communities in the NWT can find a location which meets all of these requirements. Earth cover material must often be transported considerable distances to the disposal site and is therefore a major expense.

If dumps are located in windy locations, debris can be blown back into the community or surrounding areas. The problems associated with these dumps are magnified when covering is infrequent.

Open burning of garbage also helps to reduce flying litter, but creates a smoke problem if not ideally timed and located. Fences help capture blowing litter but they are extremely expensive to construct in bedrock and permafrost areas. They also control access to sites. As long as sites remain accessible to users it can be expected that disposal sites will be messy and aesthetically unfavourable (Heinke and Wong, 1990a).

5.2 Problems Associated with Isolation and Small Populations

By most North American standards all of the 61 communities in the NWT are small (population under 4,000), except for Yellowknife (population approx. 13,000). Of the remaining 60 communities only 13 have a population of over 1,000.

All the communities are isolated considering the distance that they are separated from the rest of Canada. Only 15 are accessible by year-long highway transport. The remainder are accessible only by winter roads, water or air.

Solid waste disposal problems associated with small, isolated communities are:

- lack of roads;
- lack of equipment;
- difficulty in implementing recycling and recovery programs;
- increased problems associated with wildlife; and
- other associated problems.

Lack of Roads

A lack of roads leading to and from communities makes it difficult and expensive to locate landfill sites an acceptable distance from communities and airports (Soberman, Heinke and Lovicsek, 1990). Transport Canada's guidelines state that landfills should be a minimum of 8 km from airports to prevent the hazard of birds interacting with airplanes.

The mean shortest distance between the solid waste disposal site and the airstrip for all NWT communities for which data was available is approximately 2 km (Soberman, Heinke and Lovicsek, 1990). In certain cases it would be extremely expensive to remedy this situation.

Other benefits of locating landfill sites away from communities are that:

- if burning of garbage is conducted, smoke is not as easily blown into populated centres;
- if animals are attracted to the dump they do not pose a threat to the community; and
- it is not as aesthetically unfavourable as when a dump is within view of the community.

Lack of Equipment

In most small communities it is not economically feasible to have all the necessary equipment. It is seldom practical to keep a bulldozer at the landfill site continuously, as it is needed for other tasks in the community.

Usually it is not economically feasible to perform volume reduction of waste by methods such as shredding, milling and incineration.

Difficulty of Recycling and Resource Recovery

The difficulty which arises in implementing a waste recycling and recovery program is due to remoteness and small populations.

> "A northern location compounds the difficulties experienced by communities in the south. Populations are generally small; therefore, volumes of recovered materials are small. There are usually no local markets, so material must be shipped south over long distances and at high costs."
> (Smith et al., 1986)

The recycling of scrap metal is of particular concern. If not recycled, it is discarded in landfill sites, bulky waste dumps or left indiscriminately around communities. Since very little compaction of bulky wastes can be achieved, proper disposal of these wastes drastically increases the required landfill site volume.

In an attempt to get old appliances, vehicles and bulky wastes out of the back yards of Iqaluit, the municipality held a special day where people could leave bulky items at the curb (Collings, 1990). The items were picked up, free of charge, and taken to the dump. The day was very successful, but within a few weeks time much of the wastes had been hauled back into other people's backyards by local residents.

The most cost effective way that recycling is implemented in the North is by scavenging. At the Yellowknife dump

> "... a considerable number of patrons haul and deposit their own wastes as well as scavenge and recycle previously discarded refuse. These scavengers recycle material from the landfill to

> such a degree that the city feels that 'on some days deposits and withdrawals are roughly equal'."
> (Environment Canada, 1985)

Although scavenging is hazardous from a health and safety point of view, it is one of the few economically feasible methods of recycling waste in arctic communities.

Problems Associated with Wildlife

The NWT is a land rich in wildlife. Animals and birds can be a problem when they feed off garbage. Ravens, gulls and foxes can be carry disease if they scavenge at landfill sites. Black bears and polar bears are not only a nuisance but can also be dangerous, particularly if a dump is located close to a community. For example, the dump in Norman Wells is frequented by approximately 20 black bears (Whiteman, 1990). The bears are a nuisance, but if the expense were spent to fence the dump and prevent the bears' access, they may go into town to scavenge and become a hazard to the community.

Other problems with wildlife at dump sites are associated with hazardous materials which may be present. If bioaccumulating substances are consumed by wildlife at dumps, they can accumulate up the food chain. These waste can result in birth defects, weak egg shells, illness or death in humans and animals.

5.3 Other Problems

Other factors contributing to solid waste problems in cold regions are:

- lack of responsibility for proper management;
- nomadic, explorative, and transient attitude toward occupation of the region;
- tendency to escape from severe weather by spending as little time as possible outside;
- shortage of trained personnel;
- relatively high cost of operations; and
- insufficient information on generation and characteristics of solid wastes.

(World Health Organization, 1985)

These factors are gradually changing. For example, there is now more information on generation and characteristics of solid wastes in the North. In 1989, composition and generation studies were performed in three arctic communities (Heinke and Wong, 1990b). Information obtained from this study is vital for implementing appropriate solid waste management plans.

5.4 Present Conditions of Landfill Sites in the NWT

In the NWT, landfill sites are located:

- on flat terrain;
- on sloping terrain;
- in a natural depression; and
- in a constructed trench.

Several operations employ open burning to reduce waste volume, flying litter and scavenging. In most cases, covering is infrequent, ranging from weekly to annually or even less.

Recently a survey was conducted to determine the status of landfill sites in the NWT (Heinke and Wong, 1990c). The survey results were used to determine if sites were:

open dumps - These are typically unsupervised, uncontrolled operations without regular covering or compaction of wastes. Wastes of all types are dumped at a designated site without any attempt to segregate the domestic waste from the human or bulky wastes. These sites were considered by the authors to be unacceptable from and environmental standpoint.

open dump/landfills - These sites are similar to open dumps except in that a limited form of control is introduced by providing separate areas for bulky wastes and honey bag disposal. These sites were considered by the authors to be temporarily acceptable environmentally.

modified landfills - Every aspect of the modified landfill is engineered from its conception to its closing. Wastes are periodically compacted by mechanical means and covered with a layer of earth or other suitable material. Although the schedule for compaction and cover is typically more frequent than for an open dump/landfill operation, problems of exposed refuse, attraction to animals and birds, surface and groundwater contamination, open burning and scavenging still exist. The authors considered these sites to be acceptable from an environmental standpoint.

The study revealed that of the 33 communities giving adequate data:

- 12 were acceptable (modified landfills);
- 17 were temporarily acceptable (open dump/landfill); and
- 4 were unacceptable (open dump).

Seven (16%) were deficient from a public health standpoint and four (9%) were deficient from an environmental standpoint. None of the sites could be considered sanitary landfill sites. The survey showed an improvement since 1982 when a study (Christensen, 1982) revealed that 58% were deficient from a public health perspective and 32% were environmentally deficient.

5.5 References

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CHAPTER 6

OVERVIEW OF REGULATIONS GOVERNING HAZARDOUS WASTES IN THE NWT

There are many acts and regulations governing the handling, transportation and disposal of hazardous wastes and products in the NWT. Many of these acts and regulations only briefly mention hazardous wastes and goods, while others focus totally on them. Unfortunately all of the regulations are written in a manner which makes them indecipherable to the average person. These regulations and how they pertain to hazardous wastes will be discussed in this chapter. The most important acts discussed are the Environmental Protection Act and the Transportation of Dangerous Goods Act.

This chapter is not a comprehensive summary of each regulation but merely describes how they apply to hazardous substances. The regulations are divided into two categories:

- federal regulations; and
- territorial regulations.

Some concluding remarks will be made in section 6.3.

6.1 Federal Acts Regulations

Arctic Waters Pollution Prevention Act (Her Majesty, Queen Elizabeth II, 1985a)

This act was developed because Parliament "recognized Canada's responsibility for the welfare of the Inuit and other inhabitants of the Canadian Arctic". The government also recognized that "the preservation of the peculiar ecological balance that now exists in the water, ice and land areas of the Canadian Arctic" could be threatened by "developments in relation to the exploitation of the natural resources of arctic areas". It prohibits the deposition of waste of any type in the arctic water or the on mainland or islands of the Canadian Arctic that may allow it to enter the arctic waters except as authorized by these regulations. It allows for the seizure of a ship and cargo if suspected of breaking the regulations.

Canada Water Act (Her Majesty, Queen Elizabeth II, 1985b)

This act was set up because "pollution of the water resources of Canada is a significant and rapidly increasing threat to the health, well-being and prosperity of the people of Canada and to the quality of the Canadian environment". It outlines measures that should be taken to provide for water quality management in those areas of Canada most critically affected. This act is very vague and non-specific, and provides no standards of measurement.

Environmental Protection Act (Her Majesty, Queen Elizabeth II, 1989a)

This act begins with: "It is hereby declared that the protection of the environment is essential to the well-being of Canada." It specifies a priority list of toxic substances and regulates the quantity, concentration, and location of release of these substances into the environment. It also provides a lists of prohibited substances, toxic substances requiring export notification, and hazardous wastes requiring export or import notification. Ocean dumping and hazardous waste export are also regulated under this act.

Federal Mobile PCB Treatment and Destruction Regulations (Ministry of the Environment, 1990a)

These regulations are under the Environmental Protection Act. They set performance standards for the operation of mobile PCB destruction equipment. Of key importance are the standards for gases, liquids and solids released from these systems.

Ocean Dumping Regulations (Ministry of the Environment, 1990b)

These regulations are also included under the Environmental Protection Act. They specify conditions for a permit to dump at sea, and require reports in the event of emergency dumping.

Fisheries Act (Her Majesty, Queen Elizabeth II, 1985c)

This federal act protects fish and fish habitats. It states:

> "no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat....No person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish."

Hazardous Product Act (Her Majesty, Queen Elizabeth II, 1985d and 1989b)

This act and amendments authorize the advertising, sale or importation into Canada of any hazardous product which is likely to endanger the health or safety of the public.

Controlled Products Regulations (Ministry of Consumer and Corporate Affairs, 1988)

These regulations, under the Hazardous Product Act, define 4 classes of controlled products:

- Class A - compressed gas;
- Class B - flammable and combustible material;
- Class C - oxidizing material; and
- Class D - poisonous and infectious material.

It does not deal with the disposal of these products.

Northern Inland Waters Act and Regulations (Her Majesty, Queen Elizabeth II, 1985e)

This act protects the inland water resources of both the Yukon and NWT. It prohibits any person from depositing or permitting the deposit of waste of any type in any waters or in any place that may allow the waste to enter any waters, except in accordance with conditions of a licence, or as authorized by the regulations.

Territorial Lands Act (Her Majesty, Queen Elizabeth II, 1985f)

This act allows any territorial lands to be set aside as land management zones. These zones are intended to protect the ecological balance or physical characteristics of the area.

Canadian Oil and Gas Drilling and Production Regulations (Her Majesty, Queen Elizabeth II, 1978a)

These regulations (under the Territorial Lands Act) specify practices for the safe start-up, operation and closure of drilling sites. They also regulate the storage of oil, requiring that tanks be surrounded by a dike or ditch of capacity greater than the tanks they surround. It states that reasonable precautions should be taken to prevent salt water, drilling fluid, waste, oil or refuse from tanks or wells from flowing over land. It prohibits the dumping of flammable produce or waste produce into open bodies of water or onto a highway or public road.

Canadian Oil and Gas Land Regulations (Her Majesty, Queen Elizabeth II, 1978b)

These regulations, under the Territorial Lands Act, make no mention of the disposal of hazardous wastes.

Canadian Mining Regulations (Her Majesty, Queen Elizabeth II, 1978c)

These regulations, also under the Territorial Lands Act, also make no mention of the disposal of hazardous wastes.

Territorial Land Use Regulations (Her Majesty, Queen Elizabeth II, 1978d)

These regulations, also under the Territorial Lands Act, state conditions that are needed for Class A and B permits for petroleum fuel storage. A Class A permit is required for petroleum storage facilities exceeding a total of 80,000 L capacity and a single tank exceeding 4,000 L. A Class B permit is required for a total storage volume of 4,000 L and a single tank of a capacity of 2,000 L or greater. They also restrict the quantities of explosives which can be used without a Class A or Class B permit.

Transportation of Dangerous Goods Act (TDGA) (Environment Canada, 1989)

The TDG legislation regulates the transportation and classification of hazardous products and wastes. It regulates the documents that will be carried with a waste shipment, and what safety measures will be taken when waste dangerous goods are being handled or transported. It classifies wastes into nine classes of dangerous goods (see section 2.4).

6.2 Territorial Acts and Regulations

Asbestos Disposal Guidelines (Department of Renewable Resources, 1990)

This is basically a list of government departments that should be contacted to receive information and approval for the disposal of asbestos in the NWT.

Consolidation of the Environment Protection Act (Department of Renewable Resources, 1989)

This is not an official statement of the law. It is prepared for assistance only. It allows a chief environmental protection officer to require any person to:

a) install safeguards to prevent the discharge of contaminants into the environment;

b) site, transport or store any contaminant in a safe manner; or

c) to have on hand at all times such equipment and material necessary to alleviate the effect of any discharge of contaminants as may be specified in the order.

If a discharge does occur, an inspector may order that the discharge be stopped immediately or reduced to a specified level by a specified day. Repair, remedy or clean-up of any injury or damage to the environment as a result of a discharge can be ordered. Also under this act "No person shall permit premises owned, occupied or abandoned by him to be unsightly."

Pesticide Act (Government of the Northwest Territories, 1989)

This act is to intended to control and regulate the use and disposal of pesticides. It prohibits the application of pesticides on an open body of water. Pesticides must be stored in containers bearing proper labels. It also describes methods of improper disposal of pesticides and empty pesticide containers.

Transportation of Dangerous Goods Ordinance (Stanley Associates Engineering Ltd., 1986)

The territorial government regulates the transport of dangerous goods within the NWT by this parallel legislation to the federal TDGA.

6.3 Summary

These acts and regulations seem to merely define hazardous products, environmental standards and improper practices, but do not offer many guidelines or standards for proper disposal. It is also obvious that these regulations are poorly enforced, and unknown to many hazardous waste generators.

In the Philippines, hazardous wastes were being improperly disposed of not because of lack of regulations but because of lack of organization of regulations (Tolentino, Brabante, and David, 1990). Before the revolution in 1986, hazardous wastes were handled by as many as ten government agencies. The new government felt a need for a "new revitalized agency" to cope with the worsening situation. A clear, less complicated regulatory system was needed. This may also be the case in the NWT.

In general in the NWT, larger generators are more aware of regulations. Small generators are often unaware that they are producing hazardous wastes. These small quantity generators individually produce barely noticeable amounts, but collectively they produce a significant portion of the hazardous wastes generated. Regulations must be made applicable and understandable by the average small quantity generator.

6.4 References

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Her Majesty, Queen Elizabeth II, 1989a. "An Act Respecting the Protection of the Environment and of Human Life and Health". Canadian Environmental Protection Act, S.C. 1988, c.22. Queen's Printers for Canada, Ottawa.

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CHAPTER 7

CONCLUSIONS

Finding background information on hazardous wastes in the NWT was both interesting and challenging. Several conclusions were made after completing this portion of the study.

1. There is a basic lack of information on the subject of hazardous wastes in the NWT.

2. There is a definite problem with the disposal of hazardous and bulky waste in the NWT.

3. There is a need for a territory-wide survey on hazardous waste to obtain information on quantities, types and location of hazardous wastes generated and stored in the NWT.

4. There is a general lack of understanding of and concern for hazardous waste in communities in the NWT.

5. There is a lack of disposal options for hazardous waste generators in the NWT.

6. Regulations regarding hazardous wastes in the NWT are overlapping and confusing.

7. There is a need for both community and industry guidelines for the disposal of hazardous and bulky wastes in the NWT.

8. There is a need for the development of facilities for the management of hazardous and bulky wastes in the NWT.

Part II

SURVEY DEVELOPMENT AND RESULTS

CHAPTER 8

INTRODUCTION

After the background of the study was collected, it was obvious that an up-to-date inventory on hazardous wastes in the NWT, both generated and stored, was needed. Several of the previous studies on waste management and hazardous wastes in the NWT stressed the need for such an inventory. These studies are discussed in Chapter 3.

Once it was determined that an inventory should be obtained, the following questions remained:

- what method would be used to obtain the data?
- what system should be used to classify regions, businesses and wastes?
- how should the survey be designed?
- which wastes should be included? and
- how will the results be evaluated?

The answers to these questions will be discussed in this part of the report. The inventory results will also be stated and discussed.

CHAPTER 9

INVENTORY METHOD

There are several approaches which can be used to determine quantities of hazardous wastes generated. They include:

- the rate method;
- the permit data method;
- the disposal data method;
- the transport data method; and
- industry survey (Reid, Crowther and Partners Limited, 1980).

9.1 The Rate Method

To apply the rate method one must obtain:

- the number of production employees working in each industry or business; and
- literature values of waste generation rates per production employee in each type of industry or business.

This data is then used to estimate the amount of hazardous wastes generated by each industry. This approach has the advantage of requiring relatively little time to obtain data. The disadvantages of using this type of method in the NWT are:

- most businesses are small, with under 10 employees which reduces the accuracy of this method;
- waste generation rates are calculated in the South and may be significantly different from those in the NWT;

- many businesses are multi-faceted in the North, performing more than one service. In these cases, specific industry generation rates cannot be applied;
- information on current treatment and disposal practices cannot be obtained; and
- amounts of wastes in storage cannot be calculated using this method.

This method is not suitable for use in the NWT, therefore another method will be used for this study.

9.2 The Permit Data Method

This method employs existing data on hazardous waste generation obtained from a regulatory agency. It assumes that industries and businesses generating hazardous wastes are maintaining records and reporting them.

The Department of Renewable Resources (DRR) has begun a program of registering hazardous waste generating companies. This system does not, however, provide all the necessary information to use this method and is not yet fully in place.

9.3 The Disposal Data Method

To apply this method, information must be available concerning types and quantities of hazardous wastes disposed. Since there are no hazardous wastes disposal facilities operating in the NWT, this method cannot be used.

9.4 The Transport Data Method

In accordance with the federal Transportation of Dangerous Goods Act (TDGA), dangerous goods transported within the territories must be reported to the Department of Transportation of the GNWT. Therefore, the Department of Transportation is aware of the different types of waste transported within the NWT. However, they do not keep records on quantities of materials transported. Also, some wastes which are of concern to this study do not fall under TDGA regulations (e.g. used oil, honey bag wastes and bulky wastes).

9.5 Industry Survey

> " A number of problems arise when trying to ascertain the types and quantities of industrial waste generated by a city or region for waste management purposes. To estimate the amount of industrial waste produced it is often necessary to carry out an industrial waste survey -this can be time consuming and costly ..."
> (Barnard, and Olivetti, 1990)

An industrial waste survey employs either personal or telephone interviews, or mail-in surveys to obtain information directly from the generator. It does not rely on theoretical data or on information reported to a regulatory agency.

> "Unfortunately, this approach is dependent upon representative sampling of all hazardous waste generating industries, and presupposes that the response to such a survey will be sufficient for extrapolation to the entire industry."
> (Reid, Crowther and Partners Limited, 1980)

Even so, waste generation methods obtained in this manner are more likely to be representative of other businesses in the NWT than those found in the literature.

This method also allows storage quantities and currently used disposal methods to be obtained. Another advantage is that local people will be made aware of hazardous wastes in their communities and are given a chance to actively take part in the study.

In the NWT there are very few industries, but this method can be modified to include small businesses, government agencies and municipalities. It is well suited to a region where limited information is available on generation rates and where permit, transport or disposal data are incomplete. Therefore, this method was the one chosen for this study.

9.6 References

Barnard, Richard, and Giancarlo Olivetti, 1990. "Rapid Assessment of Industrial Waste Production Based on Available Employment Statics". Waste Management and Research, Vol. 8, pp. 139-144.

Reid, Crowther and Partners Hazardous Wastes in Northern and Western Canada Vol. II, Environment Canada, 1980.

CHAPTER 10

IDENTIFICATION AND CLASSIFICATION OF POTENTIAL HAZARDOUS WASTES AND GENERATORS

To obtain accurate data using the industry survey method, a maximum number of hazardous waste generators must be contacted so that a representative sample can be used to calculate total generation quantities. Therefore, it was necessary to identify agencies, businesses and industries that are potential hazardous waste generators. It was also necessary to identify wastes which are hazardous.

To simplify this job, three previously known classification systems were used to classify and identify hazardous wastes and their generators. The systems used were:

- a **Geographical Classification** system to place generators in the NWT into the regions. The regions used were those assigned by the GNWT;

- an **Industry Classification** system to identify hazardous waste generating industries and businesses. The Standard Industrial Classification (SIC) system was used for this purpose; and

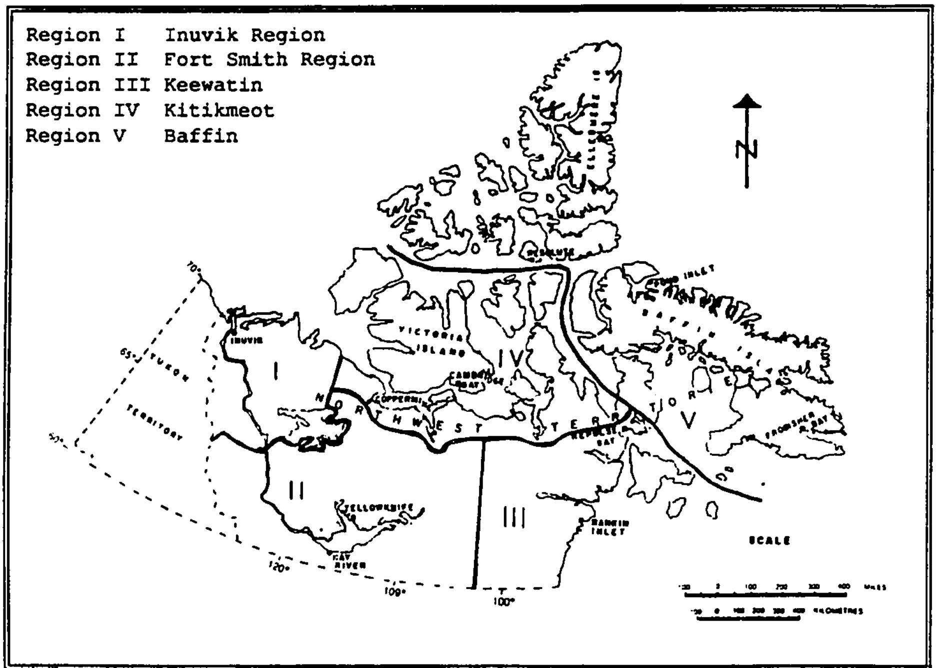
- a **Hazardous Waste Classification** system to identify and organize the wastes. The Consolidated University of California at Davis (CUCD) system was chosen for this purpose.

10.1 Geographical Classification

To avoid confusion, the regions used in this study are the same as those employed by the Government of the NWT. They are:

- Baffin Region;
- Fort Smith Region;
- Inuvik Region;
- Keewatin Region; and
- Kitikmeot Region.

These regions are shown in the map in Figure 10-1.



Source: Minister of Fisheries and Oceans, 1979.

FIGURE 10-1: GEOGRAPHICAL REGIONS IN THE NWT.

10.2 Business/Industry Classification

To classify businesses and industries, the Standard Industrial Classification (SIC) system was used. This system assigns a number (SIC) to each type of industry. Table 10-1 shows the different groupings of SIC numbers and the number of businesses in the NWT and in Canada.

TABLE 10-1
SIC NUMBERS AND CORRESPONDING INDUSTRY GROUPINGS

SIC No.	Industry Grouping	# in NWT	# in Canada	%
01-09	Agriculture, Forestry and Fisheries	11	23,104	0.05
10-14	Mining	26	9,009	0.29
15-17	Construction	291	106,978	0.27
20-39	Manufacturing	43	82,494	0.05
40-49	Transportation, Communication and Other Public Utilities	209	45,532	0.50
50-51	Wholesale Trade	137	91,550	0.15
52-59	Retail Trade	563	256,769	0.22
60-67	Finance, Insurance and Real Estate	129	69,585	0.19
70-89	Services	488	183,765	0.27
91-94	Public Administration	52	3,086	1.69
	Total	**1,949**	**871,872**	0.22

Source: Dun & Bradstreet Canada Limited, 1989.

Each one of these groups is further divided into industry specific sections each with a unique, four digit number the first two digits correspond to the industry groups. For this study these two digit SIC groups which are potential hazardous waste generators in the NWT, were consolidated into 13 producing categories. Table 10-2 shows the SIC groups which were included in each one of the producing categories. For the purpose of this study, the SIC classification 99, NWT households, was added.

TABLE 10-2
PRODUCING CATEGORIES AND CORRESPONDING SIC CODES

Producing Category	SIC Codes Included
Municipalities	82 Educational Services 91 Federal Government 92 Territorial Government 93 Municipal Government
Aviation	45 Transportation by Air
Transport and Cartage	40 Railroad Transportation 41 Local Passenger Transportation 42 Trucking and Warehousing
Vehicle and Equipment Service	55 Auto Dealers and Service Stations 75 Automotive Repair 76 Misc. Repair Services Service
Construction and Renovation	16 Heavy Construction Contractors 17 Special Trade Contractors
Communication and Utilities	48 Communications 49 Electric, Gas and Sanitary Services
Printing and Publishing	27 Printing and Publishing
Photo-Finishing	7395 Business Services/Photo-Finishing
Dry-Cleaning	7216 Personal Services/Dry-Cleaning
Other Businesses	24 Lumber and Lumber Products 32 Stone, Clay, Glass and Concrete Products 34 Fabricated Metal Products 39 Misc. Manufacturing Industries
Metal Mining	10 Metal Mining
Oil and Gas Extraction	13 Oil and Gas Extraction
NWT Households	99 NWT Households

note: SIC 99 was created for this study.
A four digit SIC code is used for SIC 72 and 73 because not all included businesses are potential hazardous waste generators.

10.3 Waste Classification System

The system used for classifying types of waste generated is the Consolidated University of California of Davis System. It is summarized in Table 10-3.

TABLE 10-3
CONSOLIDATED UNIVERSITY OF CALIFORNIA AT DAVIS
HAZARDOUS WASTE CLASSIFICATION SYSTEM

(1) Organic Sludges and Still Bottoms (no oil)
- organic sludges containing metals
- halogenated still bottoms
- non-halogenated still bottoms

(2) Solvents and Organic Solutions
- halogenated
- non-halogenated
- mixed

(3) Oils and Greases
- waste lube oil
- other oils and greases

(4) Oil/Water Mixtures
- emulsified and free oil/water
- mixtures

(5) Organic and Oily Residues
- leaded gasoline
- organic food waste oil

(6) Heavy Metal Solutions and Residuals
- spent plating or etching
- rinse and less concentrated aqueous solutions
- sludges from plating and etching lines
- sludges from treatment of solution containing metals.

(7) Miscellaneous Chemicals and Products
- organic chemicals
- inorganic chemicals
- salt
- infectious

(8) Paint and Organic Residuals
- latex paint and sludge
- solvent based paint and sludge
- wash and rinse waters
- adhesives and glue

(9) Aqueous Solutions with Organics (90% water)
- alcohols and organic acids
- halogenated solvents
- non-halogenated solvents

(10) Anion Complexes
- cyanide
- sulphide
- other complexes

(11) Sludges and Inorganic Residuals
- ash
- spent catalyst

(12) Pesticide and Herbicide Wastes
- high concentration organics
- high concentration with metals
- cleanup water and dilute solutions

(13) PCB Wastes
- high concentration liquid (>500 ppm)
- medium concentration liquids (<500 ppm)
- contaminated soil (<50 ppm)

(14) Clean-up Residuals
- solvent and organic waste
- inorganics and metals
- pesticides and herbicides

(15) * Concentrated Human Sewage
- bagged sewage
- pump out sewage (if disposed of with solid wastes)
- sewage sludge

(16) * Household Hazardous Wastes
- hazardous wastes originating from private households

note: These wastes can be included in several of the other categories but, because of the difficulties involved with collecting, quantifying, and regulating these wastes, they will be grouped into a separate category.

(17) * Bulky Wastes (although not hazardous from a health point of view, these wastes are included in this study)
- metal wastes
- construction wastes

Source: Moneco Consultants Limited, 1990, and Proctor & Redfern Limited, 1982.

note: * indicates that these classifications were added for this study.

This is a straight forward and commonly used hazardous waste classification. The last three categories are not part of the CUCD system but have been added for this study.

10.4 References

Dun & Bradstreet Canada Limited,1989. "Dun's Marketing Statistics Selector Form".

Minister of Fisheries and Oceans, 1979. "Northwest Territories Fishery Regulations, Amendment". Fisheries Act. SOR/79-485, In Canada Gazette, Part II, Vol. 113, no.13.

Moneco Consultants Limited, 1990. Characterization of Hazardous Waste Generation and Disposal in the Yukon. Prepared for Community and Transportation Services, Yukon Territory Government. Whitehorse, Yukon.

Proctor & Redfern Limited,1982. Waste Quantities Study. Prepared for the Ontario Waste Management Corporation. Toronto, Ont.

CHAPTER 11

DESIGN OF THE SURVEY

The next step of the process was to design and distribute the questionnaire. The survey method, recipients, questionnaire format and basic aims were carefully considered. These factors were all tailored to a northern perspective.

11.1 Survey Method

As mentioned previously there are three ways of conducting an industry survey:

- personal interviews;
- telephone questionnaire; and
- mail-in questionnaire.

It was decided that the survey would take the form of a mail-in questionnaire rather than telephone or personal interviews. This would allow a large number of people to be contacted, give them sufficient time to complete the survey and would be relatively inexpensive.

In an attempt to increase the response to the survey, before the surveys were distributed each participant was sent a letter explaining the study and informing them about the survey. In addition, industries, power companies and retail chains were telephoned directly to explain the study, and ask for their cooperation.

11.2 Recipients of the Questionnaire

The recipients of the questionnaire can be divided into seven groups:

- industries;
- Department of Public Works (DPW);
- power companies;
- retail chains;
- hamlet administrators;
- tax-based community administrators; and
- potential hazardous waste generating businesses in tax-based communities.

These six groups will now be described further.

Industries

Industries contacted in the NWT were:

- metal mines; and
- oil and gas companies.

These industries were contacted directly by telephone before receiving the questionnaire.

Department of Public Works

The head office of the DPW was contacted and asked to identify quantities of hazardous wastes generated by their activities in individual communities. This information could be collected from personal records, by telephone or by distributing copies of the survey to individuals in each community.

Power Companies

In a similar manner the head offices of the following power producers were contacted:

- Northwest Territories Power Corporation;
- Northland Utilities; and
- ICG utilities.

Retail Chains

In smaller communities, the only retail outlets are Northern and/or Co-op stores. The head offices of these chains were contacted, not because they generate hazardous wastes but because they sell products which are dangerous goods and may one day end up as household hazardous wastes. Quantities of these items sold can be used to estimate quantities of household hazardous wastes generated.

Hamlet Administrators

In the NWT there are four different types of communities:

- Tax-based communities (7);
- Hamlets (36);
- Settlement Corporations (3); and
- Unorganized (15).

The communities and their current political status are listed in Table 11-1. Settlement corporations and unorganized communities are small communities of under 200 people. They were considered to generate negligible amounts of hazardous wastes and were therefore omitted from the survey.

TABLE 11-1
POLITICAL STATUS OF COMMUNITIES IN THE NWT.

Tax - based Communities	**Hamlets**	**Settlement Corporations**	**Unorganized Settlements**
Fort Simpson	Aklavik	Arctic Red River	Bathurst Inlet
Fort Smith	Arctic Bay	Enterprise	Colville Lake
Hay River	Arviat	Fort Resolution	Dettah
Inuvik	Baker Lake		Fort Good Hope
Iqaluit	Broughton Island		Hay River Reserve
Norman Wells	Cambridge Bay		Jean Marie River
Yellowknife	Cape Dorset		Kakisa Lake
	Chesterfield Inlet		Nahanni Butte
	Clyde River		Nanisivik
	Coppermine		Rae Lakes
	Coral Harbour		Snare Lake
	Fort Franklin		Snowdrift
	Fort Liard		Trout Lake
	Fort McPherson		Tungsten
	Fort Norman		Wrigley
	Fort Providence		
	Gjoa Haven		
	Grise Fiord		
	Hall Beach		
	Holman		
	Igloolik		
	Lac La Martre		
	Lake Harbour		
	Pangnirtung		
	Paulatuk		
	Pelly Bay		
	Pond Inlet		
	Rae-Edzo		
	Rankin Inlet		
	Repulse Bay		
	Resolute Bay		
	Sachs Harbour		
	Sanikiluaq		
	Spence Bay		
	Tuktoyaktuk		
	Whale Cove		

Most hamlets in the NWT do not have a large number of potential hazardous waste generating businesses or industries. The majority of hazardous wastes in hamlets are generated by:

- the hamlet maintenance garage;
- the housing co-op;
- the nursing station;
- the DPW;
- the power corporation;
- local maintenance shops, service stations and businesses; and
- individual households.

The DPW and power corporations were contacted separately. It was felt that biomedical wastes should be dealt with separately and therefore these wastes were excluded from this study. Some private medical, dental and veterinary clinics were contacted to identify types and quantities of wastes generated and currently used disposal methods in these facilities. Hazardous wastes generated by individual households were estimated using survey values obtained from retail outlets.

The Senior Administrative Officer (SAO) of each hamlet was contacted and asked to work with the rest of the community in order to quantify hazardous wastes generated by other community activities. They were also asked to identify hazardous materials which were known to be present in the municipal landfill.

Tax-based Community Administrators

In general, the tax-based communities in the NWT are larger and have more businesses than hamlets. For this reason they were only asked to identify quantities and types of hazardous wastes generated by municipal operations such as:

- vehicle maintenance;
- road construction and maintenance;
- building construction and repair; and
- printing and copying.

They were also asked to identify hazardous wastes which were known to be present in their landfill sites.

Businesses in Tax-Based Communities

Potential hazardous waste generating businesses in the seven tax-based communities identified as potential hazardous waste generators were contacted. They were asked to complete surveys specific to their business, and return the questionnaire even if they didn't produce any hazardous wastes.

11.3 Questionnaire Format

Because of the large variety of recipients, it was obvious that one single questionnaire would not suffice. The questionnaire sent out consisted of three parts.

Part A was simply the working definition of hazardous wastes as described in Section 2.2.

Part B was a section covering wastes that are generated by a wide variety of activities. (For example, used oil, waste paint and solvents)

Part C was divided into 12 sections each applying to one of the following groups:

- C-1 municipal landfill sites;
- C-2 transportation, vehicle and equipment rental and maintenance and fuel supply;
- C-3 construction, lumber, welding and fabrication, painting and glass, wood and concrete products;
- C-4 manufacturing;
- C-5 electricity, gas and communications;
- C-6 printing, publishing and photo finishing;
- C-7 educational facilities;
- C-8 retail outlets;
- C-9 medical, dental and veterinary clinics and funeral homes;
- C-10 dry cleaners;
- C-11 metal mining and oil and gas exploration; and
- C-12 other.

Each participant was sent Part A and Part B and one or more section/sections of Part C. A copy of the full survey is included in Appendix C.

11.4 Questionnaire Aims

The questionnaire had 6 main aims:

1. Obtain information about quantities, types, and locations of hazardous wastes generated in the NWT.
2. Obtain information about quantities, types, and locations of hazardous wastes stored in the NWT.
3. Obtain information about currently used disposal methods for hazardous waste in the NWT.
4. Obtain a rough estimate about the types and quantities of hazardous wastes which are disposed of in municipal landfills, sewers and sewage lagoons.
5. Obtain information on household hazardous waste generation rates and characteristics.
6. Make people in communities aware of which wastes are hazardous and arouse interest in their proper disposal.

CHAPTER 12

EXCLUSIONS FROM THE STUDY

This study was commissioned by the NWT Department of Municipal and Community Affairs (MaCA). For this reason, wastes which are under federal jurisdiction were not be included. Hazardous wastes properly managed by other territorial departments were also excluded.

Federal departments such as Environment Canada, Indian and Northern Affairs Canada and the Department of National Defense (DND) are currently organizing the clean-up of some hazardous sites. The NWT Department of Renewable Resources is in charge of accidental spills. To prevent needless duplication, the following were excluded from the survey:

- abandoned mines;
- DEW-Line sites;
- PCB's;
- spills; and
- biomedical wastes.

12.1 Abandoned Mines

Environmental Protection (EP) has collected information on abandoned mines, most on federal land. Those sites which are not on federal land may be contaminated with substances in the tailings but since tailings are minerals and minerals are under federal jurisdiction the clean-up is a federal not territorial responsibility. The clean-up of abandoned mines will therefore not be included in these guidelines.

12.2 DEW-line Sites

Information on DEW-Line sites is available from Indian and Northern Affairs Canada and the Department of National Defense. The clean-up of these sites will also be arranged by these federal departments.

12.3 PCB's

Environment Canada's Yellowknife office has accurate data on quantities of PCB's in use and storage at federal facilities, petroleum and mining industries, territorial government and telephone and power utilities in the NWT. This information is considered confidential and was not released for this study. As the majority of PCB's in the territories are already under the management of Environment Canada, they were excluded from the questionnaire.

Proper disposal methods for PCB's are not in place in the NWT. The Swan Hills Special Waste Disposal Facility in Alberta is the only permanent structure in Canada used for the destruction of PCB's. This facility does not accept out-of-province wastes. One Canadian military site in Goose Bay, Labrador, recently destroyed its PCB's in a mobile incinerator (White and McGuire, 1990, and Hunt, 1990). This may be a feasible solution for this situation, although the ash from such a site must be buried in a secure landfill. This could present a problem in the NWT where there are few locations suitable for this type of a landfill.

12.4 Spills

In the NWT, the Department of Renewable Resources (DRR) has a mandate to monitor spill containment and clean-up activities and to provide education and training programs aimed at achieving effective spill response and clean-up measures (Department of Renewable Resources, 1989). In an effort to coordinate spill response, Indian and Northern Affairs Canada maintains a 24-hour spill report line, operated by staff with technical background and experience in spill procedures. Since spills are being effectively dealt with, they do not need to be included in the guidelines of this report.

12.5 Biomedical Wastes

These wastes were excluded from the survey for the most part because it was felt that they were beyond the scope of this study. Even so, some private medical, dental and veterinary clinics were contacted to determine quantities of wastes generated by these establishments and currently used disposal practices. Proper disposal of biomedical wastes is extremely important and should not be overlooked. Further work should be done in this area.

12.6 References

Department of Renewable Resources, 1989. Spill Containment and Clean-Up Course. Course Outline. Yellowknife, NWT.

Hunt, Stephanie, 1990. "The Federal PCB Destruction Program - An Approach to the Study of Mobile PCB Incineration in Canada". In Proceedings of the Twelfth Canadian Waste Management Conference. Environment Canada, Ottawa, Ont., pp. 49-57.

White, Douglas and Captain Greg McGuire, 1990. "Goose Bay Mobile PCB Incinerator Project". In Proceedings of the Twelfth Canadian Waste Management Conference. Environment Canada, Ottawa, Ont., pp. 33-41.

CHAPTER 13

SURVEY RESULTS

This section of the report discusses the questionnaire results. The response was very good for the survey of this type. Questionnaires were received from:

- 32 % of the small businesses contacted;
- 33 % of municipalities contacted;
- 56 % of DPW's contacted;
- 64 % of retail outlets contacted; and
- 88 % of the industries contacted.

13.1 Evaluation of Questionnaires

The returned questionnaires were used to generate per-employee (for businesses) and per-population (for municipalities) hazardous waste generation rates. Rates were calculated corresponding to each waste classification (see Table 13-1) and producing category (see Table 13-5). These rates were used to estimate quantities of hazardous wastes generated by those businesses/municipalities which did not complete the survey.

Because of the high industry response rate and the diversity of waste streams from individual industries, it was felt that similar extrapolation of the data obtained from the questionnaires would not significantly increase the accuracy of the estimated quantities. Therefore, no attempt was made to estimate quantities generated by industries not responding.

13.2 Hazardous Waste Generated in the NWT by Waste Classification

The Consolidated University of California at Davis (CUCD) hazardous waste classification system was used to organize hazardous wastes generated in the NWT. Individual wastes identified from the questionnaires were categorized into one of the 17 CUCD classifications. Table 13-1 shows wastes which were included in each of the categories. Some of the categories have been omitted because the completed surveys indicated that none of the wastes belonging to these groups were generated. Categories 15,16 and 17 were added for this study.

TABLE 13-1
WASTES INCLUDED IN EACH CUCD CATEGORY

(1) Organic Sludges and Still Bottoms (no oil)
- resins
- lacquers
- dry cleaning still residues

(2) Solvents and Organic Solutions
- spent solvents
- paint thinners
- strippers

(3) Oils and Greases
- waste lube oil
- contaminated fuels
- cutting oil

(4) Oil/Water Mixtures
- emulsified and free oil/water mixtures

(5) Organic and Oily Residues
- tank sludges

(7) Miscellaneous Chemicals and Products
- photographic wastes
- ammonia
- flammable wastes
- lab reagents
- process reagents
- maintenance chemicals
- wood preservatives
- curing agents
- explosives
- waste ink
- ink sludge

(8) Paint and Organic Residual
- latex paint and sludge
- solvent based paint and sludge
- tar
- adhesives

(9) Aqueous Solutions with Organics (90% water)
- alcohols and organic acids
- anti-freeze / glycol
- battery acid
- windshield washer fluid

(14) Clean-up Residuals
- contaminated soil
- drilling mud

(15) * Concentrated Human Sewage
- bagged sewage
- sewage sludge

(16) * Household Hazardous Wastes
- hazardous wastes generated in individual households (These wastes can be included in the other categories but in this study they are considered a separate entity)

(17) * Bulky Wastes (only bulky wastes that are contaminated with hazardous substances or are themselves hazardous were quantified)
- oil filters
- containers
- gas cylinders
- spent filters

* indicates a category that was added for this study.

Figure 13-1 shows the quantities of waste generated in each group. The total quantity of hazardous waste, excluding clean-up residuals, concentrated human sewage, and bulky wastes was 2,500 tonnes/year.

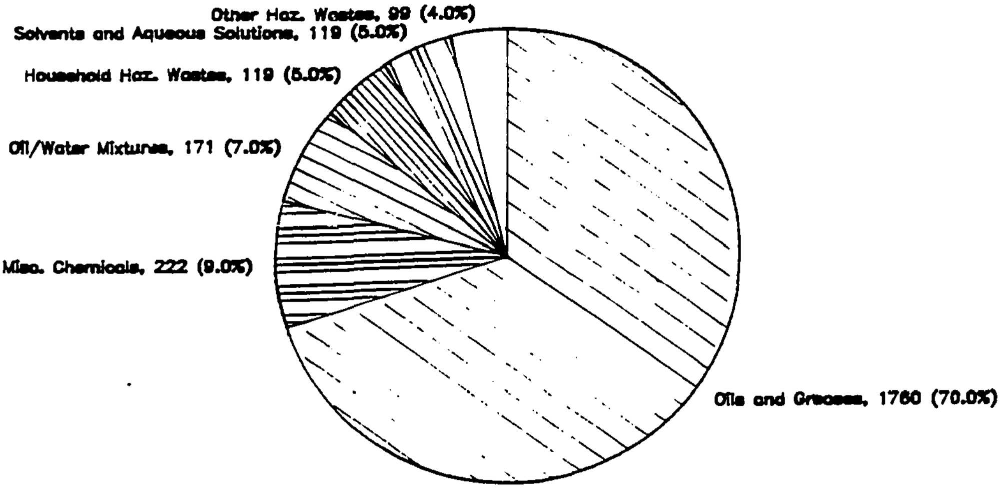


FIGURE 13-1: ESTIMATED QUANTITIES OF HAZARDOUS WASTES GENERATED IN THE NWT (TONNES/YEAR)

Specific waste quantities are given in Table 13-2.

It is clear that waste oil is the predominant hazardous waste generated. It constitutes 70% of the hazardous waste stream. This value agrees with the one determined by the Department of Renewable Resources (1990). Their telephone survey indicated that 1.9 million litres of waste oil were generated each year in the NWT. This study showed the value to be 1.8 million litres. It is also consistent with data obtained from a similar survey performed in the Yukon (Moneco Consultants Limited, 1990) which indicated that 68 % of the Yukon hazardous waste stream was oils and greases.

TABLE 13-2
ESTIMATED QUANTITIES OF HAZARDOUS WASTES
GENERATED IN THE NWT EACH YEAR

Waste Classification	**Quantity Generated/yr**	**Percent of Total**
1. Organic Sludges and Still Bottoms	6,000 L	neg.
2. Solvents and Organic Solutions	58,000 L	2
3. Oils and Greases	1,760,000 L	70
4. Oil/Water Mixtures	171,000 L	7
5. Organic and Oily Residues	60,000 L	3
7. Miscellaneous Chemicals	222,000 kg	9
8. Paint and Organic Residuals	33,000 L	1
9. Aqueous Solutions with Organics	61,000 L	3
14.*Clean-up Residuals	35,000 t	
15.*Concentrated Human Sewage	n/q	
16.Household Hazardous Wastes	119,000 kg	5
17.*Bulky Wastes		
- Oil Filters	46,000	
- Containers	11,000	
- Gas Cylinders	1,000	
- Spent Filters	2,000	
NWT Total	**2,500,000 kg**	**100**

* not included in final total and % calculations
n/q indicates that it was not quantified
neg indicates a negligible amount
note: The density of liquid wastes was assumed to be 1 g/cm^3.
The density of soil was assumed to be 2.5 g/cm^3.

13.3 Estimated Quantities of Hazardous Waste Generated in Each Region of the NWT

This study classified regions of the NWT in the same manner as the government of the NWT as shown in Figure 10-1. The break-down of hazardous wastes generated in the NWT by region is shown in Figure 13.2. This data is also given in tabular form in Table 13-3. The values in Figure 13-2 include industry. The values in the table are both including and excluding industry.

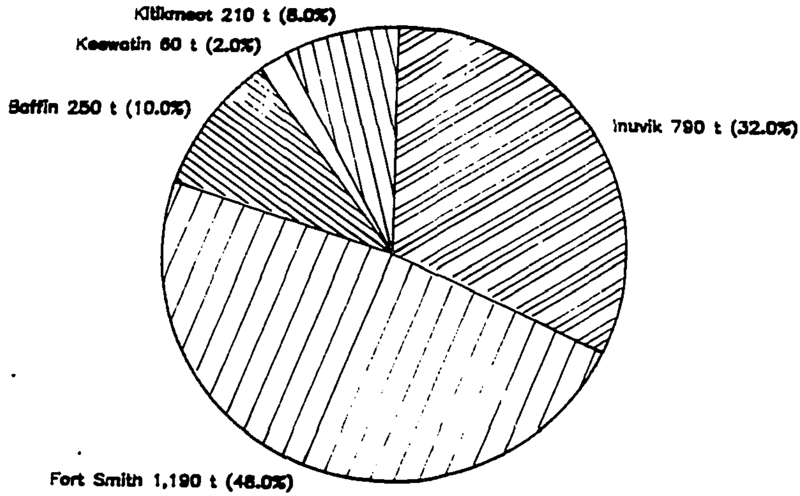


FIGURE 13-2: ESTIMATED QUANTITIES OF HAZARDOUS WASTES GENERATED IN REGIONS OF THE NWT

TABLE 13-3
ESTIMATED QUANTITIES OF HAZARDOUS WASTES GENERATED IN EACH REGION OF THE NWT

Region	Municipalities Only[a]		Including Industry[b]	
	Amount[c] (kg/yr)	Percent (%)	Amount[c] (kg/yr)	Percent (%)
Baffin Region	155,000	10	250,000	10
Keewatin Region	59,000	4	59,000	2
Kitikmeot Region	40,000	2	207,000	8
Inuvik Region	192,000	12	788,000	32
Fort Smith Region	1,147,000	72	1,186,000	48
NWT Total	**1,600,000**	**100**	**2,500,000**	**100**

Note: a Hazardous wastes generated by government, businesses and households each year.
b Hazardous wastes generated by government, businesses, households and oil and mining industries.
c This quantity was calculated assuming a density of 1 g/cm^3 for liquid wastes. This quantity does not include bulky hazardous wastes, sewage sludge, contaminated soil or drilling mud.

Table 13-4 was included to demonstrate regional differences in hazardous waste generation. It identifies quantities of each type of waste, in each region. Waste proportions differ between regions although in each case, waste oil was the predominate waste produced.

TABLE 13-4
ESTIMATED QUANTITIES OF HAZARDOUS WASTES GENERATED
IN EACH REGION AND WASTE CLASSIFICATION

Class	Baffin	Kee-watin	Kitik-meot	Inuvik	Fort Smith
Organic Sludges and Still Bottoms	1,500	200	100	1,200	3,100
Solvents and Organic Solutions	4,600	1,900	3,700	12,600	35,300
Oils and Greases	172,400	28,800	179,800	376,900	1,001,900
Oil/Water Mixtures	800	200	200	157,800	12,500
Organic and Oily Residues	5,100	400	300	19,500	34,700
Miscellaneous Chemicals (kg)	11,800	6,000	9,600	165,800	28,900
Paint and Organic Residuals	5,700	3,300	2,500	8,600	12,500
Aqueous Solutions with Organics	5,300	1,800	3,400	26,400	24,200
Clean-up Residuals (tonnes)	4,800	200	200	14,600	15,100
Concentrated Human Sewage (m^3)	2,300	1,600	1,300	20,800	17,600
Household Hazardous Wastes (kg)	42,600	16,600	7,700	19,000	33,300
Oil filters (#)	4,700	1,300	1,600	21,000	17,500
Contaminated Containers (#)	1,300	300	400	4,000	5,000
Gas Cylinders (#)	400	100	100	200	400
Contaminated Filters (#)	100	0	1,400	200	300

note: Quantities in L/yr except where indicated.

13.4 Quantities of Hazardous Waste by Producing Categories

This section describes the quantities of waste generated by each producing category. Potential hazardous waste generators were included into one of 13 groups. The industries/businesses included in each of these groups and their corresponding SIC (Standard Industrial Code) codes are shown in Table 10-2.

The quantities of hazardous waste generated by each of these groups are shown in both Figure 13-3 and Table 13-5. This data may be slightly misrepresentative because all wastes originating from hamlets were classified as being produced by municipalities or individual households. This may not be a bad approximation because there are few private businesses in the hamlets. Even so, it is must be considered an approximation.

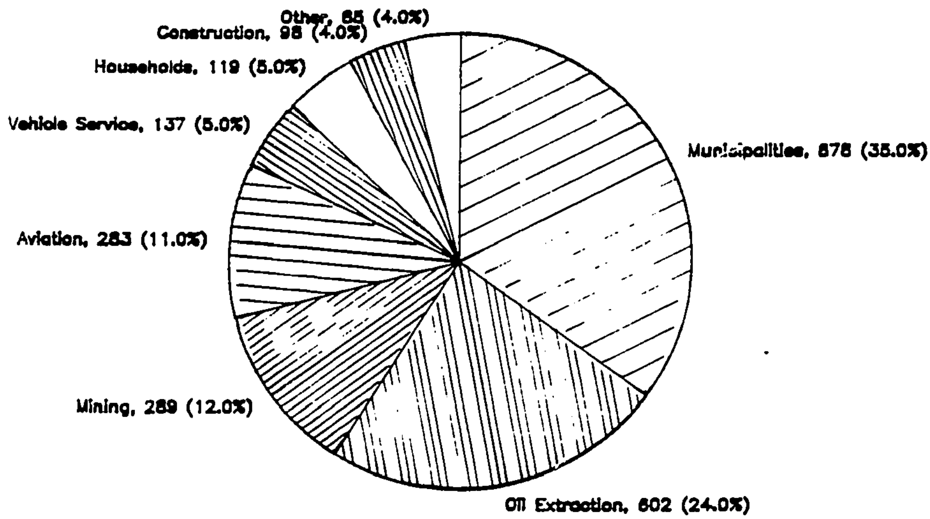


FIGURE 13-3: QUANTITIES OF HAZARDOUS WASTES BY PRODUCING CATEGORY (TONNES/YEAR)

TABLE 13-5
ESTIMATED QUANTITIES OF HAZARDOUS WASTES
GENERATED, BY PRODUCING CATEGORIES

Producing Category	Amount (kg/yr)	Percent (%)
Municipalities	878,000	35
Aviation	283,000	11
Transportation and Cartage	15,000	1
Vehicle and Equipment Service	137,000	5
Construction and Renovation	98,000	4
Communications and Utilities	40,000	2
Printing and Publishing	18,000	1
Photo-Finishing	8,000	neg
Dry-Cleaning	4,000	neg
Other Businesses	400	neg
Industries - Mining	289,000	12
- Oil Exploration	602,000	24
NWT Households	119,000	5
NWT Total	**2,500,000**	**100**

neg indicates a negligible amount

13.4 Quantities of Each Waste Category, Generated by Each Producing Category

This section evaluates producers of each hazardous waste types. This information is helpful because it indicates which generators are the biggest concern in each waste category.

Organic Sludges and Still Bottoms

Resins, lacquers and dry-cleaning residues are included in this category. Major generators are municipalities, construction, and dry-cleaners as can be seen by Table 13-6. Clearly, dry-cleaners (although there are only 6 in the NWT) produce the largest portion of these wastes. All the dry-cleaners responding to the survey indicated that the substance they used was PERC (perchloroethylene). PERC is harmful to

TABLE 13-6
QUANTITIES OF ORGANIC SLUDGES AND STILL BOTTOMS
BY PRODUCING CATEGORIES

Producing Category	Quantity (L/yr)	Percent of Total
Municipalities	800	13
Aviation	50	1
Construction and Renovations	1,000	16
Dry Cleaning	4,100	69
Industries	50	1
Total	**6,000**	**100**

the liver and kidneys in humans and has been shown to cause cancer in laboratory animals (Alaska Department of Environmental Conservation, 1986).

Solvents and Organic Solutions

Wastes included in this group are spent solvents, paint thinners and strippers. They can be extremely toxic to people and animals and are generated by a large variety of producing categories (see Table 13-7). They also comprise a small portion of household hazardous wastes.

TABLE 13-7
QUANTITIES OF SOLVENTS AND ORGANIC SOLUTIONS
BY PRODUCING CATEGORIES

Producing Category	Quantity (L/yr)	Percent of Total
Municipalities	11,400	20
Aviation	7,100	12
Vehicle and Equipment Service	6,100	10
Construction and Renovation	6,400	11
Communication and Utilities	700	1
Printing and Publishing	2,100	4
Mining Industry	18,000	31
Oil Exploration	6,400	11
Total	**58,000**	**100**

Waste Oils and Greases

Seventy percent of hazardous waste generated in the NWT belong to this category. They are generated by almost every producing category. This is demonstrated by Table 13-8. These wastes also make up a large portion of household hazardous wastes in most jurisdictions.

TABLE 13-8
QUANTITIES OF WASTE OILS AND GREASES GENERATED
BY PRODUCING CATEGORIES

Producing Category	Quantity (L/yr)	Percent of Total
Municipalities	793,100	45
Aviation	236,600	13
Transportation and Cartage	13,800	1
Vehicle and Equipment Service	114,100	7
Construction and Renovation	76,400	4
Communication and Utilities	34,200	2
Printing and Publishing	100	neg
Other Businesses	400	neg
Mining Industry	251,500	14
Oil Exploration	239,700	14
Total	**1,760,000**	**100**

neg indicates a negligible value

During use, oil can be contaminated with a variety of hazardous constituents such as lead, arsenic cadmium and chromium. These constituent make it hazardous. The main problem associated with waste oil disposal is that many people do not realize that it is hazardous. Several municipalities insisted that no hazardous waste was generated in their community until it was brought to their attention that waste oil was hazardous. One of the comments on a questionnaire returned from Norman Wells stated that "This town has oil seepage naturally for 100 years into the McKenzie River. Why is oil a problem?" This attitude reveals that public education is needed to make people realize the hazards of waste oil.

Oil/Water Mixtures

These wastes include both emulsions and easily separatable oil/water mixtures. They comprise a large portion of the hazardous waste stream. Table 13-9 shows the quantities and producers of these wastes.

TABLE 13-9
QUANTITIES OF OIL/WATER MIXTURES
BY PRODUCING CATEGORIES

Producing Category	**Quantity (l/yr)**	**Percent of Total**
Municipalities	1,100	1
Aviation	900	neg
Vehicle and Equipment Service	6,800	4
Construction and Renovation	700	neg
Communication and Utilities	4,300	2
Mining Industry	1,000	1
Oil Exploration	156,700	91
Total	**171,000**	**100**

neg indicates a negligible amount

Organic and Oil Residues

This category is comprised of fuel tank sludges. These bottom sediments are generated at a surprisingly high rate. The questionnaire indicated that 60,000 L of these sludges were generated each year. The break-up by producing category is shown in Table 13-10.

TABLE 13-10
QUANTITIES OF ORGANIC AND OILY RESIDUES
BY PRODUCING CATEGORIES

Producing Category	Quantity (L/yr)	Percent of Total
Municipalities	2,000	3
Aviation	34,600	58
Mining Industry	2,000	3
Oil Exploration	21,400	36
Total	**60,000**	**100**

neg indicates a negligible amount

Miscellaneous Chemicals

As shown in Table 13-1 this group covers a wide range of items. The most significant of these wastes are photographic wastes, flammable wastes and process reagents. They were identified as being produced by every group except the "other" category and also comprise a portion of household hazardous wastes. These quantities are shown in Table 13-11.

TABLE 13-11
QUANTITIES OF MISCELLANEOUS CHEMICALS
BY PRODUCING CATEGORIES

Producing Category	Quantity (kg/yr)	Percent of Total
Municipalities	31,000	14
Aviation	1,600	1
Vehicle and Equipment Service	400	neg
Construction and Renovation	2,600	1
Communication and Utilities	300	neg
Printing and Publishing	15,400	7
Photo-Finishing	8,100	4
Mining Industry	6,200	3
Oil Exploration	156,600	70
Total	**222,000**	**100**

neg indicates a negligible amount

Paint and Organic Residuals

Wastes included in this section are solvent based paints and sludges, tar, and adhesives. They are produced by the generators indicated in Table 13-12. They also comprise a substantial portion of household hazardous wastes.

TABLE 13-12
QUANTITIES OF PAINT AND ORGANIC RESIDUALS
BY PRODUCING CATEGORIES

Producing Category	Quantity (L/yr)	Percent of Total
Municipalities	22,000	66
Aviation	100	neg
Vehicle and Equipment Service	1,300	4
Construction and Renovation	9,400	29
Mining Industry	100	neg
Oil Exploration	100	neg
Total	**33,000**	**100**

neg indicates a negligible amount

Aqueous Solutions with Organics (90% Water)

This category includes alcohols and acids, anti-freeze, battery acid and windshield washer fluid. Many of these wastes arise from vehicle and equipment repair. A substantial quantity of acid is generated by oil and mining industries. Refer to Table 13-13 for details on these quantities.

TABLE 13-13
QUANTITIES OF AQUEOUS SOLUTIONS WITH ORGANICS (90% WATER)
BY PRODUCING CATEGORIES

Producing Category	**Quantity (L/yr)**	**Percent of Total**
Municipalities	16,200	26
Aviation	1,800	3
Transportation and Cartage	1,300	2
Vehicle and Equipment Service	8,600	14
Construction and Renovation	1,400	2
Communication and Utilities	500	1
Mining Industry	10,100	17
Oil Exploration	21,000	35
Total	**61,000**	**100**

Clean-up Residuals

This group is comprised of contaminated soil, and drilling mud. Quantities of are shown in Table 13-14. It was not included in the total quantity of hazardous wastes generated in the NWT, because drilling mud is generally treated on site and contaminated soil is considered a spill product. Spill products were excluded from this study (see section 12.4).

TABLE 13-14
QUANTITIES OF CLEAN-UP RESIDUALS
BY PRODUCING CATEGORIES

Producing Category	**Quantity (tonnes/yr)**	**Percent of Total**
Municipalities	1,100	3
Aviation	17,6000	50
Vehicle and Equipment Service	2,800	8
Communication and Utilities	3,300	10
Printing and Publishing	100	neg
Mining Industry	100	neg
Oil Exploration	10,000	29
Total	**35,000**	**100**

neg indicates a negligible amount

Hazardous Bulky Wastes

As previously described, bulky wastes are large non-biodegradable items which are difficult to handle at disposal sites. Most bulky wastes are inert, but some may be contaminated with hazardous materials. These "hazardous" bulky waste were grouped into four sections:

- oil filters;
- contaminated containers;
- gas cylinders; and
- spent filters.

Tables 13-15 through 13-18 show the quantities and producing categories of these wastes.

TABLE 13-15
QUANTITIES OF OIL FILTERS
BY PRODUCING CATEGORIES

Producing Category	**Quantity (#/yr)**	**Percent of Total**
Municipalities	11,500	25
Aviation	1,800	4
Transportation and Cartage	800	2
Vehicle and Equipment Service	7,000	15
Communications and Utilities	4,700	10
Construction and Renovation	1,200	2
Other Businesses	100	neg
Mining Industry	3,600	8
Oil Exploration	15,700	34
Total	**46,000**	**100**

neg indicates a negligible amount

Oil filters, although not exactly bulky, are difficult to dispose of because they are non-biodegradable and may contain waste oil. Contaminated containers are hazardous because they contain residues of former, toxic contents. Waste gas cylinders may be under pressure and may contain toxic or flammable materials. Spent filters can contain a large variety of hazardous substances.

TABLE 13-16
QUANTITIES OF CONTAMINATED CONTAINERS
BY PRODUCING CATEGORIES

Producing Category	Quantity (#/yr)	Percent of Total
Municipalities	1,900	16
Aviation	500	5
Vehicle and Equipment Service	100	1
Construction and Renovation	500	4
Printing and Publishing	100	1
Photo-Finishing	500	5
Other Businesses	200	2
Mining Industry	3,000	27
Oil Exploration	4,400	39
Total	**11,000**	**100**

TABLE 13-17
QUANTITIES OF GAS CYLINDERS
BY PRODUCING CATEGORIES

Producing Category	Quantity (#/yr)	Percent of Total
Municipalities	500	50
Construction and Renovation	500	50
Total	**1,000**	**100**

TABLE 13-18
QUANTITIES OF SPENT FILTERS
BY PRODUCING CATEGORIES

Producing Category	Quantity (L/yr)	Percent of Total
Dry-Cleaning	200	10
Mining Industry	1,500	80
Oil Exploration	200	10
Total	**2,000**	**100**

13.6 Household Hazardous Wastes (HHW)

The quantities of household hazardous wastes were estimated from quantities of items sold at retail outlets which may become hazardous wastes. Retail outlets were asked to identify quantities of the following items sold each year at their stores:

- engine oil;
- small batteries;
- household cleaners;
- glues;
- paint;
- solvents;
- insecticides/pesticides;
- anti-freeze; and
- disposable diapers.

The respondents revealed that only engine oil, small batteries, household cleaners, insecticides/pesticides and disposable diapers were sold in significant quantities in the NWT. Quantities of these items which become wastes were estimated in the following manner.

Engine Oil - It is assumed that 20 % of engine oil sold is consumed during operation and the remainder becomes a waste.

Household Cleaners - Household cleaners contain a variety of dangerous substances such as ammonia, chlorine and solvents. Thirty percent of these cleaners evaporate during storage and use (National Association of College and University Business Officers, 1987). The remaining 70 % is wasted or used and flushed into sewers or holding tanks or retained in cloths which will be disposed of in landfill sites or washed and reused. It can be assumed that about half of the household cleaners used are non-toxic, therefore, 35 % of the household cleaners sold were expected to become household hazardous waste.

Pesticides and Insecticides - Most of these products will be released into the atmosphere, soil and water during use. A small portion (10 %) is assumed to be disposed of in landfill sites, sewers or holding tanks.

Disposable Diapers - These items become infectious waste which inevitably is disposed of in landfill sites. Because sewage sludge was not included into the total hazardous waste quantity, the quantity of disposable diapers will also be excluded.

Small Batteries - This group includes household batteries but not vehicle batteries. In calculating the quantity disposed it was assumed that a negligible amount of rechargeable batteries were sold and therefore 100 % of the batteries sold become hazardous waste. The problem with batteries is that they contain heavy metals. Typical heavy metal content of small batteries is shown in Table 13-19.

TABLE 13-19
HEAVY METAL CONTENT OF SMALL BATTERIES

Metal	Content (weight percent)
zinc	10 - 30 %
manganese	15 - 22 %
lead	0.05 - 0.6 %
mercury	0 - 1 %
cadmium	0 - 0.8 %
copper	0 - 0.1 %

source: Lugscheider, W., G. Flodl and W. Leipold, 1988

Table 13-20 shows the estimated quantities of individual household hazardous wastes generated in different regions of the NWT. Table 13-21 shows the per-person quantities of hazardous wastes calculated.

Literature values for household hazardous waste generation vary significantly between different jurisdictions. They range from 1.2-2.5 kg/person/yr (Technology Resource Inc., 1989) and 3.0-5.0 kg/household/yr (Moneco Consultants Limited, 1990). The average NWT HHW generation rate of 3.0 kg/person/yr corresponds well with the literature considering that the HHW generation rates calculated for the NWT will also include some of the wastes generated by small businesses which purchase supplies directly form retail outlets. In this way, wastes resulting from small businesses in hamlets, which may have otherwise been omitted from the inventory, are included in the household hazardous waste category.

TABLE 13-20
ESTIMATED REGIONAL QUANTITIES OF HOUSEHOLD HAZARDOUS WASTES

Region	Engine Oil (L/yr)	Clean-ers (L/yr)	Pesti-cides (kg/yr)	Bat-teries (kg/yr)	Disp. Diapers (kg/yr)
Baffin Region	31,700	8,800	30	2,200	300
Keewatin	11,600	3,500	90	1,400	900
Kitikmeot	3,300	2,900	30	1,400	300
Inuvik Region	10,900	6,400	190	1,600	1,900
Fort Smith Region	8,500	18,900	560	5,400	5,600
Total	**66,000**	**40,000**	**900**	**12,000**	**9,000**
Percent of Total*	**55 %**	**34 %**	**1 %**	**10 %**	**n/i**

* Assuming a density of 1 g/cm³ for liquid wastes and excluding disposable diapers.
n/i not included

TABLE 13-21
ESTIMATED REGIONAL PER PERSON HHW GENERATION RATES

Region	Total (kg/yr)	Gen. Rate kg/person
Baffin Region	42,600	4.1
Keewatin	16,600	3.3
Kitikmeot	7,700	2.0
Inuvik Region	19,100	2.5
Fort Smith Region	33,300	1.4
Total	**119,000**	**3.0**

In larger centres such as Hay River and Yellowknife, many small businesses obtain supplies from wholesale outlets and suppliers. This resulted in a lower calculated HHW generation rate in the Fort Smith region. Thus, the regional differences in household hazardous waste generation rates compensate for inconsistencies in the survey rather than indicate significant regional difference in household disposal of hazardous goods.

13.7 Reported Quantities of Hazardous Wastes in Storage

Stored quantities of hazardous waste are extremely difficult to estimate. Since very few records have been kept, it is unreasonable to estimate the quantity of hazardous which have been accumulating over the year in the environment and at community landfills (Bryant, 1991). The values provided in Table 13-22 only give a general idea of stored quantities not including wastes which have been released into the environment or dumped at landfill sites.

TABLE 13-22
ESTIMATED QUANTITIES OF HAZARDOUS WASTES
STORED IN THE NWT EACH YEAR

Waste Classification	Quantity in Storage		
	Industry	Community	Total
1. Organic Sludges and Still Bottoms	---	100 L	100 L
2. Solvents and Organic Solutions	10,000 L	8,700 L	19,000 L
3. Oils and Greases	---	1,900 L	2,000 L
4. Oil/Water Mixtures	1,200 L	349,600 L	351,000 L
5. Organic and Oily Residues	200 L	2,600 L	3,000 L
8. Paint and Organic Residuals	10,000 L	100 L	10,000 L
9. Aqueous Solutions with Organics	300 L	2,100 L	2,000 L
14.*Clean-up Residuals	1,200 t	431,700 t	433,000 t
17.*Bulky Wastes - Oil Filters	55,500	152,900	208,000
- Containers	6,000	6,000	12,000
NWT Total	**84,000 L**	**956,000 L**	**1,040,000 L**

* not included in final total and % calculations
note: The density of liquid wastes was assumed to be 1 g/cm^3.
The density of soil was assumed to be 2.5 g/cm^3.

These quantities were calculated in the following manner. Average/employee storage quantities were calculated from tax-based community survey results and used to estimate those that did not respond. The same method was used for community wastes except that average/population quantities were calculated. No attempt was made to estimate quantities stored at industries because of the high industry response rate and inaccuracy of extrapolation.

13.8 Disposal Methods Revealed by the Survey

The survey revealed that much of the hazardous waste in the NWT is not merely dumped at landfill/dump sites. There are a variety of methods used for the disposal of difficult wastes. Because of this variety, these methods will be described for specific wastes instead of CUCD categories.

Table 13-23 shows disposal methods used for waste oil. It also shows the corresponding data determined by Stanley Associates Engineering (1990). The results are similar, especially considering that the 1990 study grouped open burning and incineration together. Thus, 41% of the waste oil was "flared". This study showed that 50 % of waste oil was disposed by combustion without heat recovery.

One dissimilarity was the marked decrease in the amount of waste oil used for dust suppression. This may be a result of an effort to increase awareness in communities of the hazards of road oiling. The table also demonstrates that industries employ different disposal methods than do municipalities and small businesses.

TABLE 13-23
TYPICAL DISPOSAL METHODS USED FOR
WASTE OIL IN THE NWT

Disposal Method	Industry	Communities	Total	DRR 1990[a]
Landfill/Dump	---	6 %	2 %	2 %
Sewer	---	7 %	2 %	---
Dust Suppression	1 %	12 %	4 %	14 %
Open Burning*	3 %	14 %	6 %	41 %
Burned for Heat	---	27 %	7 %	17 %
Incineration*	60 %	2 %	44 %	---
Sent Out of NWT	24 %	2 %	18 %	13 %
Store	12 %	28 %	16 %	2 %
Fire Practice	---	2 %	1 %	11 %

a Source: Stanley Associates Engineering, 1990.
* The 1990 study considered both Open burning and Incineration as one category, "flared".

Disposal methods used for other wastes are shown in Table 13-24 and 13-25. Once again, there is a obvious difference in how industries and small quantity generators deal with these substances. Many industries and businesses showed a concerned effort in proper disposal of hazardous wastes. Some innovative disposal techniques were employed by both industry and business. One dry-cleaning business owner said that he brought filter residues to Saskatchewan for recycling when he went home.

Disposal methods used for wastes not mentioned here are included in the Appendix D.

TABLE 13-24
TYPICAL DISPOSAL METHODS USED IN COMMUNITIES
FOR SEVERAL OTHER HAZARDOUS WASTES

Disposal Method	Spent Solvents	Waste Paint	Batteries	Oil Filters	Gas Cylinders
Landfill/Dump	57 %	86 %	16 %	87 %	4 %
Sewer	1 %	---	---	---	---
Dust Suppression	8 %	---	---	---	---
Open Burning	6 %	7 %	1 %	12 %	---
Burned for Heat	9 %	---	---	---	---
Incineration	16 %	7 %	---	1 %	---
Sent Out of NWT	---	---	74 %	---	78 %
Recycle	---	---	5 %	---	---
Reuse	---	---	---	---	14 %
Store	3 %	---	5 %	---	4 %

TABLE 13-25
TYPICAL DISPOSAL METHODS USED BY INDUSTRY
FOR SEVERAL OTHER HAZARDOUS WASTES

Disposal Method	Spent Solvents	Waste Paint	Batteries	Oil Filters
Landfill/Dump	neg.	72 %	9 %	13 %
Sewer	---	---	---	---
Dust Suppression	---	---	---	---
Open Burning	5 %	28 %	3 %	83 %
Burned for Heat	---	---	---	---
Incineration	---	---	---	1 %
Sent Out of NWT	5 %	---	7 %	neg.
Recycle	---	---	37 %	---
Reuse	---	---	---	---
Store	90 %	---	44 %	3 %

neg. indicates that a negligible amount was disposed of in that manner.

13.9 Comments Provided by Wastes Generators

In general the questionnaires were completed very well. Many contained very interesting, informative and thought-provoking comments. Typically, people expressed a concern for proper disposal options and facilities. Some showed an interest in using waste oil as a heating source. The need to ship bulky and hazardous wastes south was also mentioned. A desire to participate in recycling programs was expressed by several businesses and industries.

13.10 References

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PART III

GUIDELINES FOR THE MANAGEMENT OF HAZARDOUS WASTES IN THE NWT

CHAPTER 14

INTRODUCTION

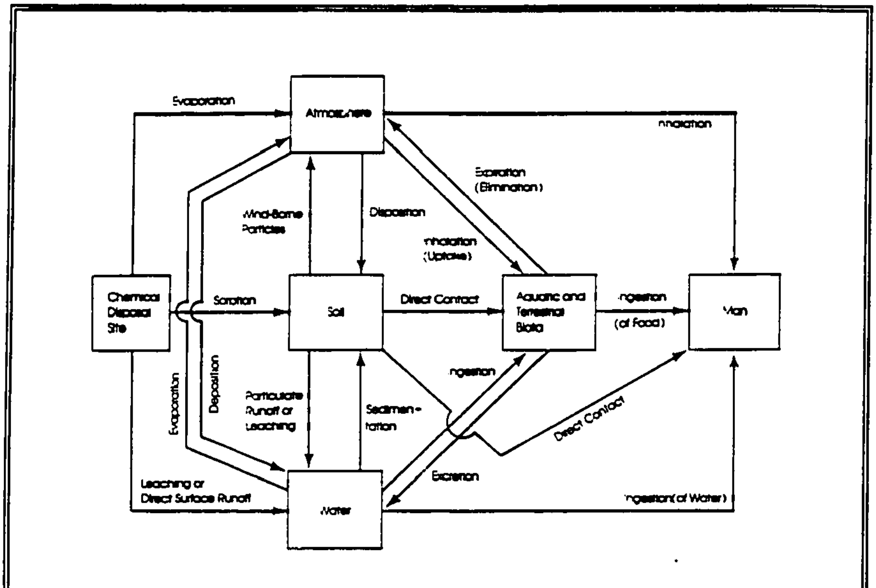
Why is safe hazardous waste disposal essential? The answer to that question is: "Because hazardous wastes are harmful to people and the environment". As described in Chapter 2 hazardous wastes can be:

- flammable;
- corrosive;
- toxic;
- infectious;
- explosive;
- radioactive; or
- persistent in nature.

Improper disposal of these wastes can cause harmful constituents to be released into the environment. Figure 14-1 shows how this release takes place.

As demonstrated in the figure, hazardous wastes can contaminate;

- ground water;
- surface water bodies;
- atmosphere;
- soil; and
- aquatic and terrestrial biota.



Source: Batstone, Smith and Wilson, 1989a

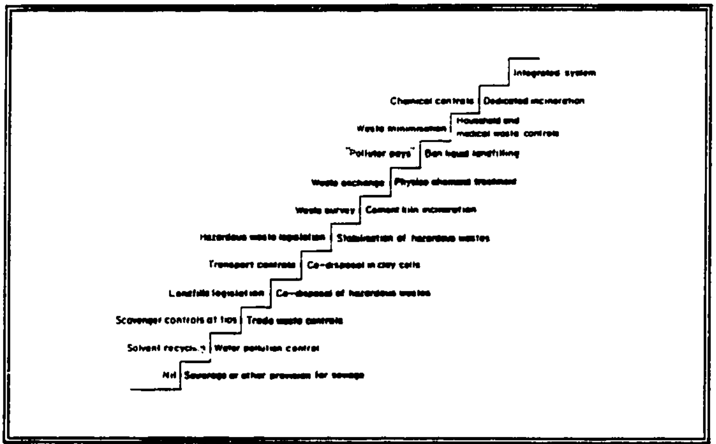
FIG. 14-1: PHYSICAL AND BIOLOGICAL ROUTES OF TRANSPORT OF HAZARDOUS SUBSTANCES, AND THE POTENTIAL FOR HUMAN EXPOSURE.

The transport of contaminants in surface waters results in rapid and extensive dispersion. Drinking water can be contaminated by run-off, or by animals carrying contaminated particles from dump sites. Some animals may also transfer contagious diseases or dangerous chemicals to communities. Release of waste materials into the sea and fresh water by leaching or run-off from disposal sites may lead to the uptake of chemicals by aquatic organisms (Batstone, Smith and Wilson, 1989a). Safe hazardous waste disposal is particularly important in the NWT because the traditional lifestyle is very dependant on the environment. A substantial proportion of many native and non-native peoples' diets consist of fish and arctic mammals. The release of hazardous waste into the environment may result in long-term exposure of the population, causing adverse health effects due to poisoning or other hazards.

Humans and animals can also be affected by direct contact with waste or empty containers. Children are an especially vulnerable group because they may play around waste bins or at dump sites (Batstone, Smith, and Wilson, 1989a).

The hazardous waste survey performed in conjunction with this study revealed that there is a substantial quantity of hazardous wastes generated in the NWT. Often these wastes are improperly disposed of because of a lack of disposal facilities, lack of concern, or ignorance of the problem. Proper solutions must be found and implemented. Standard solutions for the disposal of hazardous wastes are, in most cases, of little use in the NWT. Extreme climate, isolation, small waste volumes, and lack of the infrastructure to deal with them, may require modifications to solutions typically advocated in other locations in North America.

In other regions hazardous waste control systems have evolved as disposal problems were progressively revealed through the discovery of serious pollution incidents. With this in mind, it is unrealistic to aim for an instant transplant of technically and administratively sophisticated controls that are not even standard in more prosperous areas (Wilson and Balkau, 1990). It is more achievable to try to copy the evolution of waste management in other regions. This evolution is shown in Figure 14-2. After the infrastructure, resources and public awareness have grown more favourable, the progression to more complex control systems becomes easier.



Source: Wilson and Balkau, 1990.

FIG. 14-2: STEPS SHOWING THE EVOLUTION OF A HAZARDOUS WASTE MANAGEMENT SYSTEM.
note: The sequence of steps will vary from region to region.

In other regions (de Bruin, 1990 and Wilson and Balkau, 1990) it has been discovered that "It is better to do something than to investigate too long" Wilson and Balkau (1990) state:

> "No matter how well you do the initial survey, an accurate picture of the quantities and types of wastes will only be achieved once you have an

> operating facility. On the other hand, action cannot be taken if absolutely no information is available... while some basic estimates of waste quantities must be made before even interim facilities can be established, it is not recommended to study the problem to the point of exhaustion before taking action."

It is suggested that interim solutions allow early measurement to be made of the waste stream, and can provide immediate relief, but these solutions must be seen as a first step, leading on to more permanent measures. **The guidelines in this report are intended as the first step, not as a complete long-term solution.**

No solution, no matter how clever, can be successful without input and support from the local people. A World Bank report (Batstone, Smith and Wilson, 1989a) states it this way:

> "If changes are to be made, it is necessary that persons and groups be well-informed, be well-motivated, be cooperative and have a positive attitude toward the new ideas."

14.1 References

Batstone,Roger, James E. Smith, Jr., and David Wilson, ed., 1989a. The Safe Disposal of Hazardous Wastes: The Special Needs and Problems of Developing Countries, Vol. I. World Bank Technical Paper # 93.

De Bruin, Tom, 1990. "Co-disposal and Encapsulation". Waste Management and Research, Vol. 8, pp. 113-116.

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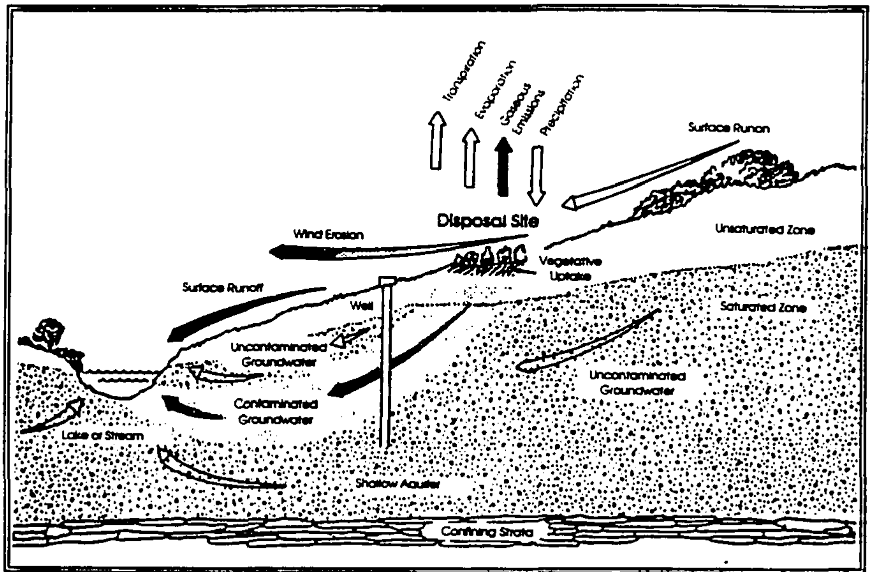
CHAPTER 15

WHY NOT LANDFILL ALL HAZARDOUS WASTES?

When hazardous wastes are disposed of at municipal landfill sites or indiscriminately dumped, toxic compounds can migrate from the site by leaching, surface run-off, wind erosion, transpiration, evaporation or gaseous emissions. This is clearly demonstrated by Figure 15-1.



Source: Batstone, Smith and Wilson, 1989b

FIG. 15-1: MIGRATION OF CONTAMINANTS FROM LAND DISPOSAL SITES

There are also several other problems with indiscriminate dumping of hazardous wastes. Mixing of incompatible wastes can cause explosions and fires. Etching of skin as well as severe corneal damage can result from contact with strong acids or alkalis (Batstone, Smith and Wilson, 1989b).

The presence of hazardous wastes increases the risks to people salvaging discarded articles at dumps. Sorting through wastes contaminated with hazardous material could cause such immediate effects as skin burns, excessive generation of tears, or even loss of consciousness. Chronic effects of this exposure are respiratory conditions from dust inhalation, and poisoning or cancer from toxic chemicals (Wellings, R.A., 1984).

Although scavenging is harmful to the people conducting it, it does provide an essential service of recycling and reuse of discarded items, thus reducing the volume of the waste stream. A paper about waste scavengers in Thailand (Kungskulniti, 1990) states that:

> "Better methods of retrieving recyclable materials and disposing of wastes should be developed. This means assisting the scavengers to work in improved facilities and in an improved environment. The idea of dispossessing them is strongly discouraged. These people are assets. They make a contribution to society's overall economic well-being by having jobs, income, and by serving an important waste recycling and disposal function."

Indiscriminate dumping of hazardous wastes in landfills or at other disposal sites is a probable cause of environmental and human damage. Long-term health effects of exposure to hazardous wastes are also largely unknown (Committee on Institutional Considerations in Reducing the Generation of Hazardous Industrial Wastes, 1985).

"Landfills for hazardous waste frequently are considered the technology of last resort"
(Batstone, Smith and Wilson, 1989b).

15.1 References

Batstone, Roger, James E. Smith, Jr., and David Wilson, ed., 1989b. The Safe Disposal of Hazardous Wastes: The Special Needs and Problems of Developing Countries, Vol. II. World Bank Technical Paper # 93.

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CHAPTER 16

TECHNOLOGIES APPLICABLE IN THE NWT

As discussed in Chapter 14, hazardous waste disposal in the NWT must go through a transitional period, employing technologies which can immediately help the situation but are not necessarily permanent solutions. Due to the high cost of transportation in the North, many of these technologies must be applied locally or on-site. Waste generators should be prepared to adapt the process to stricter regulations and future technological advances.

De Bruin (1990) states it as such:

> "To do something is better than doing nothing... It is scientifically and aesthetically pleasing to talk about high technology, incineration and waste destruction in sophisticated chemical treatment plants, while on the other side of the scale the priority is feeding, education and housing of people."

These priorities must be kept at the forefront. Even so, something must be done soon. Small-scale and relatively low cost technologies such as the following may be applicable in the NWT:

- waste minimization;
- co-disposal;
- solidification;
- encapsulation; and
- incineration.

Other technologies such as chemical oxidation, solvent extraction, biological treatment and land treatment are either not applicable, extremely costly, or only cost-effective on a large-scale.

16.1 Waste Minimization

In many cases the most economical and environmentally safe methods for the disposal of hazardous wastes begin with waste minimization. Waste minimization is the process of reducing the amount of solid and hazardous waste which a facility sends to a landfill or other disposal facility. This can be accomplished either by not creating the waste or by extracting from the waste useful products or raw materials (Alexander and Interrante, 1989).

In September, 1987, the Alberta Special Waste Treatment Facility was opened and Alberta adopted stricter hazardous waste policies. Since that time waste generators in the province have been investing in waste minimization and on-site treatment (Zeiss, 1989). When faced with strict government regulations, high disposal costs or high remediation costs to clean-up improper disposal sites, waste reduction can be an excellent method of cost reduction.

> "Though waste reduction makes good sense economically, it is often the enforcement, not cost savings, that provide the impetus."
>
> (Nichols, 1988)

In 1989 the province of Manitoba set a goal to reduce solid waste generation by 50% by the year 2000. To achieve this goal, they intend to implement the "4R's" of waste minimization: Reduce, Reuse, Recycle, and Recover (Fenton, Spiegel, Ferguson, and McCormick, 1990).

There are four methods which can be used for waste minimization (Technology Resource Inc., 1988). They are:

- source reduction;
- on-site recycling;
- on-site reuse; and
- off-site recycling.

Source reduction consists of process change and raw material substitution to reduce the amount of solid and hazardous waste produced. This includes simple changes such as improved housekeeping.

On-site recycling consists of reprocessing a waste so that it can be used once again for the original purpose. It is often effective for solvents and heavy metals but has little applicability for most other wastes.

On-site reuse methods recover value from a waste without actually recycling it. Examples of this are burning waste oil or solvents to recover their value as a fuel.

Off-site recycling in the NWT requires wastes to be shipped south. This can often be an expensive undertaking but is sometimes necessary.

Specific waste minimization suggestions are given for the following producing categories:

- vehicle and equipment maintenance;
- construction and renovation;
- photo-developing;

- printing; and
- dry-cleaning.

Vehicle and Equipment Maintenance This group alone generates 5 % of the hazardous wastes in the NWT, not including wastes generated by municipalities during these activities. Table 16-1 describes waste minimization methods for this group. These methods consist of source reduction and on-site reuse.

TABLE 16-1
WASTE MINIMIZATION ALTERNATIVES FOR
VEHICLE AND EQUIPMENT MAINTENANCE

Waste Category	**Waste Minimization Alternatives**
Parts Cleaning Wastes	Operate solvent sinks properly. Avoid contamination of solvent. Install lids/silhouettes on solvent tanks. Employ on-site recycling of solvent using distillation and/or filtration. Substitute biodegradable cleaners for solvents. Remove sludges frequently form cleaning tanks. Use multiple rinse tanks.
Waste Oils and Coolants	Change fluids only at required intervals. Store oil separately form other hazardous wastes. Burn used oil in on-site heating units. Avoid spillage Use drip pans to catch leaking fluids. Filter particulates from anti-freeze and reuse, where possible.
Paint Wastes	Reduce use of solvent and metal-based paints, where possible. Use high-solids coating such as powder coatings. Segregate all waste streams. Allow saturated rags and similar materials to dry before disposing. Use water-based materials and nonhazardous solvents.

Source: Raymond, 1990

Construction and Renovation Four percent of hazardous wastes in the NWT are generated by businesses specializing in construction. Municipalities also generate hazardous waste during construction-related activities. As demonstrated in Table 6-2 the key to waste minimization in this group is segregation. Separating hazardous waste from non-hazardous waste can decrease the volume that must be specially handled. Segregation also keeps wastes from becoming contaminated so they can be recycled more easily (Raymond, 1990).

TABLE 16-2
WASTE MINIMIZATION ALTERNATIVES FOR
CONSTRUCTION AND RENOVATION

Waste Category	Waste Minimization Alternatives
Spent Solvents and Cleaners	Avoid contamination of solvents with each other. Avoid water contamination of solvents. Remove sludge continuously. Monitor solvent composition. Use mechanical blasting for paint stripping. Use nonhazardous or nonchlorinated solvents, where possible.
Acid/Alkaline Cleaners	Improve operating practices. Segregate acid and alkaline wastes. Substitute nonhazardous or less hazardous materials. Remove sludge form acid or alkaline baths frequently. Reuse by filtering and rejuvenating.
Paint Wastes	Reduce use of solvent and metal-based paints, where possible. Use high-solids coatings, such as powder coatings. Segregate all waste streams.
Ignitable Wastes	Use materials in concentration below ignitability levels. Allow saturated rags and similar materials to dry before disposing. Use waster-based materials and nonhazardous solvents.

Source: Raymond, 1990.

Photo-finishing Waste minimization methods for these businesses are centred around good operating practices, recycling and recovery. Refer to Table 16-3 for more details.

TABLE 16-3
WASTE MINIMIZATION ALTERNATIVES FOR PHOTO-FINISHING

Waste Category	Waste Minimization Alternatives
Process bath Wastes	Use good operating practices. Use metallic replacement systems to settle out silver. Use chemical precipitation products. Install a metal recovery system.
Colour Developer Wastes	Use metal recovery techniques. Use counter-current rinsing. Reduce water consumption.
Bleach/Fix Wastes	Use electrolysis, persulphate salts or liquid bromine to regenerate spent ferricyanide bleach. Use iron-complexed bleaches to replace ferricyanide bleaches.

Source: Raymond, 1990.

Printing Good operating practices, product substitution, recycling, recovery and equipment modification techniques are used to minimize wastes in the printing industry. Table 16-4 has more details on these procedures.

TABLE 16-4
WASTE MINIMIZATION ALTERNATIVES FOR THE PRINTING INDUSTRY

Waste Category	Waste Minimization Alternatives
Waste Water	Use silver-free films. Use water-developed lithographic plates. Recycle spent solutions. Employ counter-current washing. Substitute iron-complexed bleaches for ferricyanide bleaches. Remove heavy metals for waste water. Use washless processing systems.
Equipment Cleaning Wastes	Substitutes less toxic or nonhazardous solvents. Schedule jobs to reduce number of cleanups. Recycle waste ink and clean-up solvent. Use automatic cleaning equipment.

Source: Raymond, 1990.

Dry-cleaning Waste reduction options that can be applied in this business are loss-prevention practices, waste stream segregation, and procedural measures that extend the life of solvents. Refer to Table 16-5 for more details.

TABLE 16-5
WASTE MINIMIZATION ALTERNATIVES FOR
DRY-CLEANERS

Waste Category	Waste Minimization Alternatives
Operating Practice	Implement procedures to minimize the loss of solvents. (See Table 16-1) Periodically replace seals and gaskets. Use equipment with monitors to ensure application of the correct amounts of solvent. Install equipment for remove water form oil and grease sludges. Install an on-site solvent distillation unit.
Housekeeping	Check for and fix leaks regularly. Repair holes in air and exhaust ducts. Keep containers of solvent closed while not in use. Clean lint screens regularly to avoid clogging of fans and condensers.

Source: Raymond, 1990.

Waste minimization methods for specific wastes will be discussed in Chapter 18. Household hazardous waste minimization methods are discussed in Appendix E.

In 1986, Jacobs' Engineering conducted a survey of 29 waste reduction projects. It is noteworthy that 55% of the projects had payback periods of less than a year, while only 7 % had payback periods of greater than 4 years (Batstone, Smith and Wilson, 1989a).

Waste minimization should be the starting point for every hazardous waste management program. In most cases hazardous waste generation cannot be totally eliminated, but reducing waste volume can reduce disposal costs significantly.

16.2 Co-disposal

Co-disposal is defined as the conscious deposition of difficult waste (including hazardous wastes) with municipal waste by mixing, so that the normal biochemical regime within the landfill is not impaired, and there is no significant deterioration in the quality of the leachate produced (Finnecy, 1988). This process utilizes the properties available in domestic waste to reduce the hazards of toxic wastes.

Research has shown that hazardous wastes in landfills are subject to physical, chemical and biological reactions which reduce the polluting characteristics of the leachate and achieve some degree of on-site treatment or immobilization. These reactions include;

- microbiological processes;
- neutralization;
- precipitation;
- oxidation and reduction;
- volatilization; and
- adsorption.

Recent studies (Rushbrook, 1989) have shown that when properly managed, co-disposal can be regarded as a safe and efficient disposal options for many difficult wastes. The United Kingdom, Greece and Ireland not only practice co-disposal, but promote 'sensible co-disposal' as a method that can be beneficial (Finnecy, 1988). French practice recognises the potential value of co-disposal.

Co-disposal is not the accidental or intentional dumping of hazardous wastes at a local landfill. It requires several precautions and adaptations.

1. The site must be investigated hydrogeologically prior to operation to ensure no surface or ground water pollution will occur. Hydrogeological investigations are relatively inexpensive and are an essential precaution. (Wellings, 1984)

2. Trenches should be cut into an old working phase, penetrating individual solid waste cells. Co-disposal with mature household waste (1-5 years old) has been found to be preferable if optimum attenuation is required. (Batstone, Smith and Wilson, 1989b)

3. Trenches should be filled with wastes, and the original seal restored. If liquid effluent is disposed it should be co-disposed with compacted waste in volumes that would ensure the total moisture content of the site remains strictly below 20%.

4. Liquid wastes or sludges should be applied at a rate that will not exceed the domestic wastes' absorptive capacity.

5. Hazardous waste should be applied an adequate distance from the bottom and sides of the landfill to ensure complete attenuation.

6. Care should be taken to avoid co-disposing waste which will not be properly treated by mature domestic wastes. These wastes are listed in Table 16-6.

7. Care should be taken to ensure that incompatible chemicals are not allowed to mix in the landfill. Figure 16-1 shows the hazards involved with the mixing of certain wastes.

8. Access to disposal sites accepting hazardous wastes

should be restricted to ensure that scavenging, improper disposal and disruption by people and animals does not occur. Signs should be posted to warn scavengers that a particular landfill or section of a landfill may contain hazardous wastes.

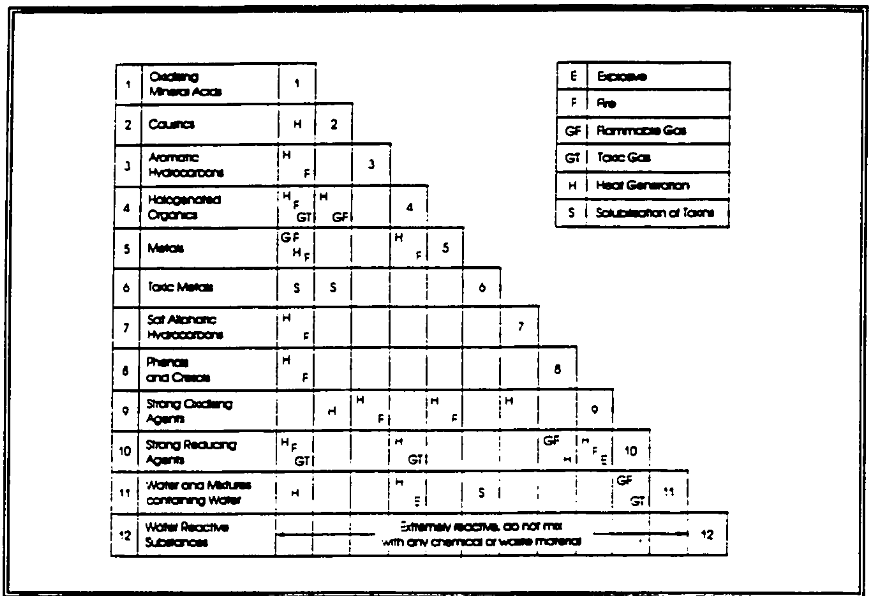
9. Constituents in leachate, temperature and water levels at the site should be monitored before, during and after the deposition of hazardous wastes in a domestic landfill. Monitoring is essential at all sites where co-disposal is practised.

10. Records should be kept of quantities, types and locations of hazardous wastes in the landfill. This will ensure that sites will not be overloaded or disturbed during future excavations.

TABLE 16-6
SUITABILITY OF SUBSTANCES FOR CO-DISPOSAL

Waste Types	**Reservation on Suitability for Co-disposal**
Acid Wastes	Concentrated acids should not be added directly. They are extremely corrosive and can cause fires and produce toxic gases. They should be added only at a rate which will maintain a near neutral pH.
Arsenic	Wastes containing up to 1% total arsenic are acceptable.
Asbestos	Must be contained in strong plastic bags and covered by at least 2 m of cover.
Cyanide Wastes	Recommended only for small quantities.
Heavy Metals	Do not exceed 0.1 kg/tonne of domestic waste.
Laboratory Chemicals	Some types only.
Mercury	Do not exceed 2 g/tonne of domestic waste.
Oils	Do not exceed 0.4 kg/tonne of domestic waste.
Oil Emulsions	Do not exceed 40 kg/tonne of domestic waste.
PCB's	Not acceptable.
Pesticide Wastes	Not acceptable.
Pharmaceuticals	Less persistent compounds only, and usually no animal tissue.
Solvent Wastes	Flammable solvents should not be accepted. Other solvents only in small quantities.
Tarry materials	Acid tars and sludges not advised.

Sources: Batstone, Smith and Wilson, 1989b
Rushbrook, 1989



Source: Batstone, Smith and Wilson, 1989a

FIG. 16-1: COMPATIBILITY OF HAZARDOUS SUBSTANCES.

It must emphasized that it is only possible to carry out co-disposal safely at a controlled landfill site, not at an open dump (Wilson and Balkau, 1990). The essence of co-disposal is that the hazardous wastes are not the major waste input into the landfill (Finnecy, 1988). If co-disposal is to be carried out in the NWT, it would require that a landfill site be carefully engineered, hydrogeologically chosen and located an adequate distance from human habitation. It would also require that domestic waste be disposed of at the site for at least one year prior to application of hazardous wastes in order to obtain an adequate volume of mature waste for maximum attenuation and neutralization of hazardous constituents.

Finnecy (1988) describes the advantages of co-disposal as such:

1. It is cheaper than almost any other method of disposal - even when done to high standards;

2. It is more universally available than any other method; and

3. It is more robust than any other method. Unlike chemical treatment and incineration, landfill disposal is very forgiving of variations in the nature, composition, and quantity of the input between widely spaced boundaries.

> "The use of co-disposal landfills should not be regarded as a 'primitive', 'low-tech' method of disposal, but one which is a practical and justifiable option for many commonly arising industrial waste types and could be used in any Western country as part of an integrated industrial waste disposal policy." (Rushbrook, 1989)

16.3 Solidification

Solidification is a technology that combines wastes with materials that tend to set, to form a solid product. In this way, the waste is captured within the solid structure (Batstone, Smith and Wilson, 1989b). The broad objective of solidification technology is to contain a waste and prevent it from entering the environment (Wiles, 1986). This is accomplished by:

- producing a solid;
- improving the handling characteristics of the waste;
- decreasing the surface area, thus reducing the potential for contamination; and

- limiting the mobility of the contaminant when exposed to leaching fluids.

The two most commonly used methods of solidification are:

- solidification through cement addition;
- solidification through the addition of lime and a pozzolanic material.

Cement-based technologies generally use ordinary Portland cement materials with additives to improve the physical characteristics and decrease the leaching losses from the resulting solidified waste. This produces a relatively high strength waste/concrete matrix (Wiles, 1986). Soluble silicates may be added to aid processing and to assist in metal containment through the formation of silicate gels.

Liquids or sludges should have a bulking agent added so that excess water will not hinder curing. Acids should first have the pH raised above 7 before solidification because cement is alkaline and will not set until a pH of 11 is reached. A minimum of about 10% cement on a weight/weight basis is generally required to produce a cured solid product with the necessary mechanical strength (Batstone, Smith and Wilson, 1989b).

Pozzolans are substances which when combined with lime can produce a low strength solid cement-like material. One of the most commonly used pozzolans is fly ash (a waste from dust emission control at coal-fired power stations). It is used in Brisbane, Australia (Razzell, 1990) with cement-kiln dust (a waste from dust emission control at cement manufacturing plants) to solidify liquid wastes. Thus, wastes provide an inexpensive source of pozzolans and lime.

There are several different methods which can be employed for the solidification of hazardous wastes (Wiles, 1986). They are:

- in-drum processing;
- mobile plant processing; and
- in situ processing.

In-drum Processing In this process the solidifying binders are added to the waste contained in a drum or other container. After mixing and setting, the solidified waste is normally disposed of in the drum.

Mobile Plant Processing This consists of portable equipment which can be easily transported and set up from site to site.

In Situ Processing In this process, binders are added directly to a lagoon or injected into soil to promote the solidification of contaminated sludge or soil. Another method of in situ solidification is to allow contaminated soil to become part of the permafrost layer, thus immobilizing contaminates in a frozen solid matrix.

There are several factors which affect solidification (Wiles, 1986):

- waste characteristics;
- temperature;
- humidity; and

- mixing.

Waste Characteristics

The physical strength of the solidified product can decrease if compounds such as salts, manganese, tin, copper and lead are present. Impurities such as organic matter, silts and some clays can cause significant delays in setting (Batstone, Smith and Wilson, 1989b). Oily sludges have been treated successfully by solidification, while biological wastes and some solvents have been found to delay or completely inhibit solidification. In general inorganics are easier to successfully solidify than organics (Wiles, 1986).

Temperature

Temperatures below 0°C will cause slow setting. This may not be detrimental although in some cases the setting is so slow that the solidified products is an unacceptable strength. Temperatures over 30°C will accelerate setting and temperatures over 66°C may completely destroy the reactions (Wiles, 1986).

Humidity

High humidity can accelerate setting, decreasing the strength of the solid.

Mixing

Extensive mixing, especially after the gel formation phase, may destroy the solid and result in a product of extremely low strength.

One of the most important advantages of solidification technology is that disposal of the treated waste can take place at sites that would normally not be able to accept hazardous wastes. This is an advantage in regions where hazardous waste producers are otherwise unable to dispose of certain wastes locally. It also requires little capital investment and can be done on a small as well as a large scale.

> "...solidification in concrete, at the very worst, still delays leaching, allowing time for naturally occurring bacteria to help destroy organic waste. Since funds for high temperature incineration are not available our methods can be called Best Available Control Technology (BACT) in our area." (de Bruin, 1990)

16.4 Encapsulation

Encapsulation is a process involving the complete coating (encapsulation) of a toxic particle or waste with a new substance (Wiles, 1986). Micro-encapsulation is the coating of individual particles. Macro-encapsulation is the coating of an group of waste particles. This section will only discuss macro-encapsulation since it is less expensive and therefore more applicable to wastes generated in the NWT than micro-encapsulation.

Macro-encapsulation can be preformed in cells as large as 2 X 3 X 6 m. In Cape Town, South Africa, pesticides, PCB's and arsenic are disposed of in 30 cm concrete cubes. These cells are poured without the formation of joints in order to minimize the chance of leaking (de Bruin,1990). The encapsulated wastes can be placed directly into a landfill site (much like co-disposal). In this way, if hazardous constituents are released from the capsule, attenuation of the wastes will take place in the domestic garbage (Pojasek, 1979).

The advantages of encapsulation are:

- wastes stabilized by this process are totally isolated from their surroundings;
- waste volume is not significantly increased, unlike solidification;
- very soluble contaminants can be contained; and
- a secondary container is usually not required.

The major disadvantages are:

- the process is often expensive;
- sludges must be dried before the process can be applied; and
- certain jacket materials are flammable.

Even so, such methods can be a safe, small-scale, local solution for some problem wastes.

16.5 Incineration

Incineration is the controlled, high-temperature oxidation of hazardous wastes. In the presence of oxygen, wastes are converted to carbon dioxide, water and incombustible solid residue (Wentz, 1989, and Glenn and Orchard, 1986) and thus rendered harmless.

> "Incineration provides the highest level of toxic organic material control of all available hazardous waste treatment technologies by a wide margin...The risks to human health from incineration of

hazardous wastes... are small compared to other risks of ordinary activities."

(APCA, 1988)

In general incineration of hazardous wastes is an expensive process requiring technically advanced equipment and large volumes of waste. Another problem with the incineration of hazardous wastes is that high capital cost requires that large facilities be constructed in a central location and wastes be transported to them. Often, centrally located hazardous waste facilities come under intense local opposition. This is demonstrated by the hazardous waste facility siting problems in Manitoba (Connell, 1990) and Ontario (Guard, 1990).

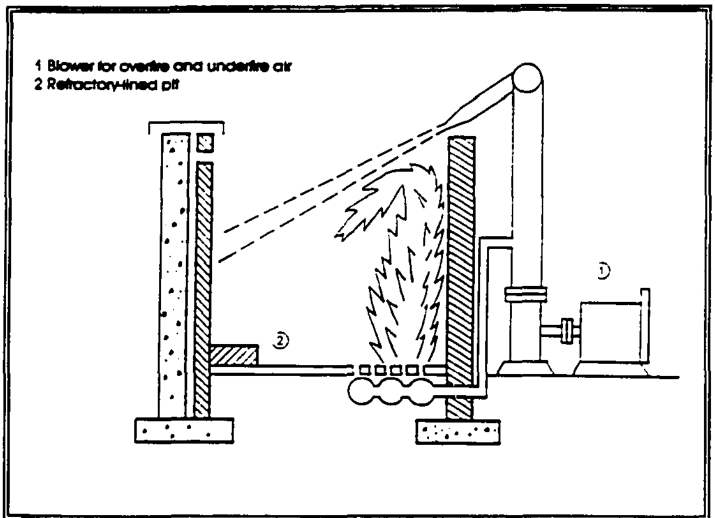
If high temperature incineration were to be considered in the NWT it would have to be on a small-scale. Two technologies may prove practical in the future in the NWT:

- open-pit incinerators; and
- mobile incinerators.

Open-pit Incinerators

A typical open-pit incinerator is about 5 m long, 2.5 m wide and 2.8 m deep. The waste is placed on a tiled floor equipped with perforated pipes to supply forced underfire air. As depicted in Figure 16-2, overfire air is directed over the top so that an air curtain is formed to permit particles to be returned to the combustion zone. This decreases the particle emissions due to incomplete combustion.

These incinerators are efficient methods of destroying wastes such as oils and organic solvents, particularly when it is not financially possible to use sophisticated incinerators (Wellings, 1984). Properly engineered designs can be a safe disposal method if located an adequate distance from habitation.



Source: Batstone, Smith and Wilson, 1989c.

FIG. 16-2: OPEN PIT INCINERATION

Mobile Incinerators

Mobile incinerators are portable units which can be moved to different locations. They can vary in capacity from small-scale (10 kg/hr) to full-scale operations (>0.5 t/hr).

Mobile units are useful when the cost of transporting waste to a central treatment facility is excessive (Batstone, Smith and Wilson, 1989c). They also create less public opposition because people often view the siting of the unit in their neighbourhood as temporary, but providing a permanent solution to a problem which may have plagued them for years (Hunt, 1990).

One problem with these facilities is that the process of actually putting these units in place and starting operation often takes years, even if they are only to be temporary fixtures in the community. This time lag is due to the lengthy and involved permitting process, frequent delays, and general uncertainties in incineration (Beuby and Jordan, 1990).

In 1990, a mobile incinerator was used in the isolated community of Goose Bay, Labrador to destroy PCB contaminated soil at a Canadian Forces base (White and McGuire, 1990). The project was quite successful and is now complete. Presently the City of London, Ontario is seriously discussing a mobile incinerator for the destruction of PCB's in London-Middlesex (Hunt, 1990).

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CHAPTER 17

STORAGE, COLLECTION AND TRANSPORTATION

Any hazardous waste management system consists of three units:

- storage upon generation;
- collection/transportation; and
- final treatment/disposal.

(Batstone, Smith and Wilson, 1989a)

This chapter deals with storage, collection and transportation.

17.1 Storage

> "How wastes are stored and handled on-site by the small quantity generator has a huge impact on the success or failure of a hazardous waste management program."
>
> (Phifer and McTigue, 1988)

Increased awareness of the effects of improper disposal of hazardous substances and the lack of disposal facilities in many regions has resulted in industries/businesses and communities implementing on-site storage as a low cost alternative to indiscriminate disposal of hazardous wastes. This practice is better than improper disposal. However, it may also create its own problems. There are both advantages and disadvantages to storage of hazardous wastes.

The advantages of storing hazardous wastes are:

- unless an accident occurs, under most circumstances the wastes are causing very little environmental damage;

- the wastes can be easily disposed of if facilities (on-site or central) are developed;
- if methods of recycling/recovery are developed, the financial value of the waste can be recovered; and
- in most cases it requires low capital and low operation and maintenance costs.

The disadvantages of storing hazardous wastes are:

- as the volume of hazardous waste stored increases, the risk of an accident occurring during storage also increases; and
- when a significant amount of hazardous waste is stored on-site the company/business is required to be registered as a hazardous waste storage facility.

One building contractor from Inuvik stated on the questionnaire for this study "Have thought about setting up a 45 gallon drum for storage (of waste oil) but then I'm left with 400 lbs of trouble." In Malysia industries which have been accumulating hazardous wastes are increasing the pressure for the establishment of a secure landfill site (Goh, 1990).

There are several factors to consider when storing hazardous waste, such as (Phifer and McTigue, 1988 and Lindgren, 1989):

- compatibility;
- segregation;

- ventilation;
- climate/environment;
- handling;
- security; and
- record keeping.

Compatibility

When storing hazardous wastes the compatibility between different types of wastes must always be considered. Table 17-1 shows a few examples of incompatible hazardous wastes. These items should be stored in a manner that minimizes the possibility of reaction with each other.

The compatibility of wastes with their containers must also be considered. For example, acids should not be stored in steel drums, and some hydrocarbons cannot be safely stored in plastic.

TABLE 17-1
COMMON COMBINATIONS OF INCOMPATIBLE HAZARDOUS WASTES

Acids and cyanides
Flammable or combustible materials and oxidizers
Strong acids and strong alkalies
Acids and water
Solvents and corrosives
Flammable liquids and ignition sources
Strong corrosives and aluminum, magnesium and zinc alloys

Source: Lindgren, 1989.

The compatibility of wastes with nearby materials and equipment is also very important, particularly when dealing with flammable wastes.

Segregation

The final destination of wastes should always be considered before storage. If recovery may be possible in the near future, wastes should be stored in a manner that will allow such recovery.

Ventilation

Hazardous wastes should be well ventilated. Highly volatile organics in particular can present a serious health hazard in storage. If possible, most wastes should be stored outside in sheds which provide free air movement.

Climate/Environment

There are exceptions to almost every rule; not all hazardous wastes should be stored outside. For example, flammable waste stored outside in drums during a hot summer can build up pressure and damage the container. Wastes with a high water content can experience freeze/thaw cycles and eventually crack and leak.

If stored outside, containers should be covered by a roof or tarpaulin, and preferably placed on an impermeable base. This prevents contact of rainwater and soil, keeps off the direct sunlight, and makes clean-up of any spills or leaks easier and cheaper. The area should be curbed or diked to collect spills, leaks and precipitation. This containment area should be capable of holding at least 10-15 % of the total volume of the stored product (Phifer and McTigue, 1988, and Lindgren, 1989).

Handling

The WHMIS (Workplace Hazardous Material Information Sheet) guidelines should be followed in all cases when handling hazardous materials. These guidelines are legally enforceable throughout Canada.

Security

Security precautions are necessary to avoid theft, sabotage, accidental discharge or harm to the public (Lindgren, 1989).

Record Keeping

Records must be maintained to achieve safe hazardous waste storage. If quantities and types of wastes are not recorded, serious problems may result in the future. Care should be taken to ensure that containers remain properly labelled during the entire time in storage.

Long-term Storage Facilities

Elevated buildings, underground storage tanks and encapsulation are three methods used for long-term storage of hazardous wastes.

Encapsulation was discussed in Section 16.4. **Underground storage tanks** have little applicability in the NWT and have recently come under intense public scrutiny in other jurisdictions (Young, 1988).

Elevated Buildings (Walters, Moffett, Sellers and Lovell, 1988) Elevated buildings could be useful in the NWT for difficult wastes. They are constructed of prestressed concrete, have extremely long lives and can withstand hurricane-force wind loadings. The advantages of long-term storage in these facilities are:

- they prevent seepage of leachate into soils and ground waters;
- they prevent emissions of volatiles;
- they prevent contact of wastes with precipitation;
- they prevent disruption of permafrost; and
- the wastes can be retrieved when technology and economics make recovery or recycling feasible.

17.2 Collection

Because most of the disposal techniques suggested in this guide are regional or on-site, very little collection and transportation is required. In the cases where collection is needed it can be performed by one or more of these three methods:

- individual pick-up:
- drop-off stations; or
- transfer stations.

Individual pick-up is appropriate for large quantity generators who generate a constant amount of waste. For example, monthly pick-up of used oil from a large vehicle repair shop could prove feasible.

Drop-off Stations consist of small, controlled access locations where hazardous materials could be placed by individuals for more convenient central pick-up. One example is the accepting of used oil and acid batteries at at automotive repair shops which are serviced by regular pick-up.

Transfer Stations (Collection Centres) are centrally located, supervised sites where hazardous materials are accepted, safely stored and sent away for disposal.

In 1989, the Municipality of Anchorage, Alaska opened a hazardous waste collection centre. The centre collects and stores hazardous wastes from small quantity generating businesses and households, and charges a fee for usage. The facility is located at the landfill site, but a drop-off centre in the city accepts residential hazardous waste one day per week. They also offer a pick-up service to businesses and homes, for an extra charge (Alaska Department of Environmental conservation, 1989 and Meade, 1990).

The wastes received are kept in their original containers, except in the case of leaking bottles. The containers are separated by absorbent material and placed in drums. The drums are labelled and shipped by barge to a facility in Seattle. The system is operating well except for lack of generator participation. The Anchorage centre is only receiving about 50% of the wastes predicted by a hazardous wastes generation study (Meade, Kathleen, 1990). This may indicate that people are still improperly disposing of small quantities of hazardous wastes because they are unaware of the site or wish to avoid paying drop-off fees. On the other hand, it could indicate that waste minimization techniques are being undertaken. In any event, this system is a good, northern example of a proper hazardous waste facility which incorporates all three types of collection.

17.3 Transportation

The safe transportation of hazardous wastes is outlined in detail in the TDG (Transportation of Dangerous Goods) regulations. Copies of these regulations and their amendments may be obtained from:

Canadian Government Publishing Centre
Ottawa, Ont.,
K1A 0S9
(819) 997-2560

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CHAPTER 18

DISPOSAL ALTERNATIVES FOR SELECTED WASTES

This chapter discusses some of the most problematic (volume or hazard) wastes in the NWT. It describes sources, hazards and disposal alternatives of each waste. Each disposal alternative is rated by the following method:

*** recommended	-	Methods rated in this manner can be considered best available technology.
** adequate	-	Alternatives rated in this manner can be considered acceptable but are not highly recommended.
* not recommended	-	These methods should not be practised.

The following wastes will be discussed:

- used oil;
- oil filters;
- acid batteries;
- spent solvents;
- anti-freeze;
- paints;
- asbestos;
- fuel tank sludges;
- drummed wastes;
- gas cylinders;
- bulky wastes; and
- household hazardous wastes.

18.1 Waste Oil

There are many problems associated with improper disposal of used oil. In addition to causing serious environmental problems such as oil slicks, used oil contains cancer-causing agents and metal contaminants that can harm people and the environment. It only takes a little oil for contamination to occur. For example:

- 1 ppm can cause taste and odour problems in drinking water;
- 35 ppm can produce a visible oil slick on water that can damage aquatic life; and
- 50 ppm can foul operations at a water treatment plant.

(Leonard, 1988)

Hazardous components in used oil are listed in Table 18-1. Health effects associated with these constituents are discussed in Appendix B.

What is Used Oil ?

The "Code of Practice for Used Oil Management in Canada" defines used oil as coming from industrial and non-industrial sources. It has been used for lubricating or other purposes and has become unsuitable for its original purpose due to the presence of impurities or the loss of original properties. The following categories of used oil are covered by the Code of Practice:

- lubricating oils (engines, turbines or gears);
- hydraulic fluids (including cutting,grinding, machining, rolling, stamping, quenching and coating

oils); and

- insulating fluid or coolant (e.g. transformer fluid).

(Jacobsen and McLaughlin, 1990)

TABLE 18-1
CONCENTRATION OF HAZARDOUS CONSTITUENTS IN USED OIL

Parameter	# of Samples Analyzed	Mean Conc. (ppm)
Metals		
Arsenic	537	17
Barium	752	132
Cadmium	744	3
Chromium	756	28
Lead	835	665
Zinc	810	580
Chlorinated Solvents		
Dichlorodifluoromethane	87	373
Trichlorotrifluoroethane	28	62,900
1,1,1-Trichloroethane	616	2,800
Trichloroethylene	608	1,390
Tetrachloroethylene	599	1,420
Total Chlorine	590	5,000
Other Organics		
Benzene	236	961
Toluene	242	2,200
Xylenes	235	3,390
Benzo(a)anthracene	27	71
Benzo(a)pyrene	65	25
Naphthalene	25	475
PCB's	753	109

Source: Rippon, 1990

Waste Oil in the NWT

a) Quantities

In the NWT waste petroleum products constitute 70 % of the hazardous wastes generated. The survey results from this study showed the amount of waste oil and greases generated each year to be almost 1.8 million litres.

b) Contaminants

Used oil in the NWT is contaminated in a manner similar to used oil in other areas. Table 18-2 shows the properties of used oil samples taken in the NWT, virgin lube oil and no.6 fuel oil. If improperly disposed of these hazardous constituents can enter the environment.

TABLE 18-2
PROPERTIES OF VARIOUS OILS AND FUELS

Property[a] (ppm)	NWT Used Oil	Used Oil (Mueller)	Virgin Lube	No. 6 Fuel
Aluminum	16	---	---	---
Arsenic*	---	17	---	---
Barium*	17	132	37	---
Cadmium*	1.4	3.1	---	---
Calcium	3,000	---	1,210	48
Chromium*	2.8	28	0	13.7
Copper	165	---	0	0.5
Iron	130	---	3	120
Lead*	100	665	0	2.9
Magnesium	600	---	675	14
Manganese	40	---	0	---
Molybdenum	4	---	---	2.3
Phosphorous	570	---	1,397	---
Potassium	50	---	<1	---
Sodium	80	---	4	241
Vanadium	1.5	---	---	---
Zinc*	710	580	1,664	---
PCB's*	---	108	---	---
Flash Point (°C)	90	100	---	100

note: * marks potentially hazardous constituents
[a] average properties
Source: Mueller Associates, 1989,
Gaukel, 199[illegible]

b) Disposal Methods

The survey performed with this study revealed that many different methods are used to dispose of waste oil in the NWT. These are shown in Table 18-3. This table demonstrates that a large portion of used oil is being disposed of in an environmentally damaging manner. Also, the majority of the potential energy value of the oil is being wasted.

TABLE 18-3
WASTE OIL DISPOSAL METHODS IN THE NWT

Disposal Method	**Percent Disposed of in this manner**
Landfill/Dump	2 %
Sewer	2 %
Dust Suppression	4 %
Open Burning	6 %
Burned for Heat	7 %
Incineration	44 %
Stored	16 %
Sent out of the NWT	18 %
Fire Practice	1 %
Total	**100 %**

Waste Oil Management in Other Jurisdictions

When planning a waste management program it is always helpful to refer to commonly used practices in other areas. The following is a brief summary of waste oil disposal practices in some of the Canadian provinces and in the Yukon.

British Colombia

In B.C. waste oil is considered a special waste under the Waste Management Act. The B.C. Ministry of the Environment considers incineration of waste oil more damaging to the environment than road oiling. In most cases, waste oil will need to be re-refined before it can be incinerated as fuel. These specifications are listed in Table 18-4. In remote communities where oil is not collected, it is dumped in landfill sites, used for dust suppression or burned off. The specifications which used oil must meet in order to be acceptable for dust suppression are also shown in Table 18-4.

TABLE 18-4
B.C. WASTE OIL SPECIFICATIONS

Constituent/ Property	For use as a Fuel Allowable Level*	For Road Application Allowable Level*
Flash Point	43°C minimum	60°C minimum
Total Arsenic	5.0	20
Total Cadmium	2.0	3.0
Total Organic Halogens (as Cl)	1,500	2,000
Total Chromium	10	10
Total Lead	50	1,000
Total PCB's	3.0	5.0
Total Zinc	500	1,000

* Levels are maximums in mg/L unless otherwise indicated.
Source: NWT Department of Renewable Resources, 1989

Alberta

The Alberta Department of the Environment does not encourage the use of used lubricating oils for road oiling or land treatment. Re-refining is preferred. Road oiling can continue if these guidelines are voluntarily followed.

GUIDELINES FOR ROAD OILING IN ALBERTA

1. No person shall, without approval, apply waste oil to any land for the purpose of road dust control unless:
   a) The waste oil has the following properties:
      Total lead 500 mg/L max.
      PCB's 5 mg/L max.
      Flash point 61 °C min.
   b) The location of the proposed application will be more than 25 m from surface water or a domestic well.
   c) The application rate will not result in a visible run-off of oil beyond the travelled portion of the road or other land.
   d) Permission has been given by the owner of the land to which the oil is applied.

2. Persons engaged in the practice of road oiling should develop contingency plans, including the identification of appropriate equipment and personnel, to deal with any oil spills.

(Rippon, 1990)

Saskatchewan

Road oiling and dumping in landfills are undesirable practices for used oil and are being eliminated. Re-refining is considered best. Waste oil is used as a replacement for bulk fuel by asphalt plants (Stanley Associates Engineering, 1987).

Manitoba

Manitoba has a large number of facilities burning used lube oil as fuel. Most of these are service stations, fleet owners or other large quantity generators. Regulations specific to used oil have not yet been developed (Stanley Associates Engineering, 1987).

Ontario

In Ontario re-refining is considered the best practice, although incineration is another alternative. Road oiling for dust suppression was banned in 1989. In remote areas, used oil is handled by individuals. It is probably dumped or reused.

Quebec

In Quebec it is forbidden to spread new or used oil for dust control purposes. It may be burned for heating if it meets the standards listed in Table 18-5. The specifications for other uses (e.g. wood protection, automobile rust proofing,etc.) are also listed in that table.

TABLE 18-5
SPECIFICATIONS FOR USE OF USED OIL AS A FUEL IN QUEBEC

Constituent/ Property	For Use as a Fuel Allowable Level*	For Other Uses Allowable Level*
Arsenic	5	5
Cadmium	2	2
Chromium	10	10
Lead	100	100
PCB's	3	0.15
Total Halogens	1,500	1,500
Flash Point	38°C minimum	38°C minimum

* Levels are maximums in mg/L unless otherwise indicated. Any dilution to meet these standards is prohibited.
Source: NWT Department of Renewable Resources, 1989.

Labrador

In Labrador no oil is sent out for re-refining. A mining company collects oil in Labrador City to use as a fuel or fuel additive. The military uses waste oil in fire control exercises. Very little road oiling is done. Some oil is burned off at municipal landfill sites, used for burning brush or other wastes, or indiscriminately disposed.

(Department of Renewable Resources, 1989)

Yukon

There are a number of industries using waste oil burners in the Yukon (Moneco Consultants,1990). Jacobsen and McLaughlin (1990) suggest that road oiling with waste oil is not environmentally sound and could be banned in the future. Some waste oil is used for burning garbage and brush, is burned in barrels or pits, or is indiscriminately dumped.

Previous Studies on Used Oil Disposal in the NWT.

Previous attempts have been made in the past to establish methods of using waste oil as a fuel. In 1987, the Department of Renewable Resources funded a study (Stanley Associates, 1987) evaluating several alternatives for treating used oil. The three alternatives discussed were:

1) Re-refine the oil in Southern Canada
2) Build a re-refinery in the NWT.
3) Burn the waste oil as a fuel for heating.

Of these alternatives the third alternative was the only one found to be economically viable.

In 1988, the Department of Renewable Resources commissioned another study on waste oil. This study (Boreal Consulting Services Ltd., 1988) evaluated different types of furnaces which could be used to burn waste oil. The conclusion was that burning waste oil in furnaces specifically designed for that purpose is an economical alternative for the disposal of the oil. The pay back period for a typical installation was found to be under five years.

The Environmental Protection Act considers the risks due to contaminants released to the atmosphere during combustion in approved waste oil appliances to be far less than the environmental risk of raw waste oil. It should be noted that although waste oil furnaces dispose of harmful used oil, they also generate small quantities of sediment, filter cake and spent filters which must be considered "hazardous waste" and disposed of appropriately.

In 1987, a project was implemented in Hay River to design and construct a waste oil fired system to heat the town's water supply. Due to financial restraints the project was scrapped in 1989 (Stanley Associates Engineering Ltd., 1989).

Alternatives for Waste Oil Disposal

The Canadian Petroleum Products Institute (CPPI) states:

> "... re-refining the used oil collected would be the ideal method of recycling this resource... However, facilities for doing this work are not available in all parts of Canada... other environmentally acceptable methods of reusing or recycling the oil have to be used. These would be in keeping with the principles of sustainable development by either recovering the used lubrication oils as re-refined or reprocessed oils or by capturing their heating value as fuel."
>
> (Wenzler, 1990)

This is a very important point to remember when developing waste oil disposal guidelines. These factors were all considered while preparing the guidelines in this report.

1) *** **Burning in Furnaces Specifically Designed for Waste Oil**

Environmental damage due to waste oil can be minimized by burning in oil furnaces specifically designed for waste oil. Waste oil furnaces are designed specifically to handle waste oil. The pay back period for such projects was found to be less than 5 years (Boreal Consulting Service Ltd., 1988). Used oil burned in appropriate heating equipment has the lowest recovery cost because this equipment will burn any mixture, within reason, of used oil products, including contaminated fuel, engine oils, hydraulic oils and heavy gear oils (Jacobsen and McLaughlin, 1990).

The advantages of using specific waste oil burning equipment are:

- close monitoring at collection sites would not be required since they can burn a large variety of oils;
- only one storage container would be required; and
- collection could be conducted in tanks located at landfill sites in small and larger communities to dispose of the used oil produced in that area.

Caution must be taken to properly dispose of the small quantities of sediment and filter cakes which are themselves hazardous waste. These wastes can be stored and sent south, solidified in concrete or deposited in a specified co-disposal site. See sections 16.2 and 16.3 for details on these procedures. During combustion of used oil in small boilers only 50-85% of the lead and 30-60% of the zinc is emitted into the atmosphere (Mueller Associates, Inc. 1989).

2) *** **Blending with Fuel Oil and Burning in Conventional Furnaces**

In areas where capital is not available to install special used oil burning furnaces, used oil can be blended with fuel oil at a maximum ratio of 1:100 (used oil:fuel oil). This would result in a composite oil of the composition shown in Table 18-6. The contaminant levels of blended oil falls well within limits set in B.C. and in Quebec.

TABLE 18-6
COMPOSITION OF USED OIL BLENDED WITH FUEL OIL 1:100

Constituent/ Property	Blended NWT Oil[1] (mg/L)	Allowable Level[2] (mg/L)
Arsenic	---	5.0
Barium	0.2	---
Cadmium	0.1	2.0
Chromium	0.1	10
Lead	1	50
Zinc	7	500
PCB's	---	3.0
Flash Point	100°C minimum	43°C minimum

1 Based on average NWT oil (Gaukel,1990) blended with fuel oil (1:100)
2 B.C. waste oil specifications for use as a fuel

The blending process requires no pretreatment, unless water is present. Water can be removed from the bottom of storage drums or tanks by use of a drain valve. This water should be disposed of in sewage lagoons where some degree of biological treatment will occur. The small amount of waste oil in the water should not foul lagoon operation as long as a total concentration of less than 50 ppm oil in the lagoon is maintained.

Waste oil can be blended in tank farms, day tanks or individual fuel tanks. At all times a dilution of 1:100 or greater should be maintained. Hajdu, Matulay and Nyiro (1988) found that burning filtered used oil in conventional oil boilers without cleaning the gas fume did not cause harmful air pollution if the conditions of burning were chosen properly. When oil is filtered prior to blending, spent filters and filter cakes must be sent south for disposal, solidified in concrete or deposited in a specified co-disposal site. Sediment removed from empty containers or tanks should also be disposed of in this manner.

3) ***** Sent South for Re-refining**

The advantage of this method is that it causes virtually no environment damage in the NWT except if a spill occurs during transportation. The disadvantages are:

- it is expensive even if markets pay for the used oil;
- spills could occur during transportation;
- the energy value of the used oil is shipped south;
- it is not very practical for communities that are not accessible by road; and
- it cannot be considered an efficient means of recycling because of the tremendous amount of fuel required to transport the oil south.

4) **** Incinerated**

Waste oil can be safely disposed of by high temperature incineration. Unfortunately, facilities are not currently available in the NWT for this type of disposal. A mobile incinerator or open pit incinerator (see section 16.5) could be employed for this purpose.

Problems with this method are:

- **Expense.** No matter how this is performed it is an expensive process.
- **Storage.** If incineration is infrequent it may require a significant amount of storage space.
- **Loss of potential energy.** Unless energy recovery is

performed during incineration, all the fuel value of the oil is lost.

5) **** Co-disposal at a Specified Co-disposal Landfill Site**

Co-disposal has very limited applicability for used oil because the attenuation of oils in landfills is largely through absorption by solid wastes. After waste oil is absorbed, degradation is extremely slow. In order to keep the oil concentration in leachate within the range of household hazardous waste, the loading rates should not exceed 0.4 kg of oil per tonne of refuse. Oils should not be disposed of within the top layer of refuse at co-disposal sites because they are very stable (Batstone, Smith and Wilson, 1989b).

6) **** Re-refining or Reprocessing**

Although these practices are preferred in most provinces there are several problems associated with applying this technology in the NWT:

- **Expense.** It has been found (Stanley Associates Engineering Ltd., 1987) that the establishment of a re-refining plant in the NWT is not economically feasible. This may change in the future if the price of oil increases significantly.
- **Isolation and small sizes of communities.** Obtaining adequate volumes of oil at a central processing plant would require that oil be shipped long distances at high transportation costs.
- **Disposal of hazardous waste generated during the**

process. Depending on the process, significant quantities of hazardous waste are generated during the upgrading of waste oil. These would require proper disposal facilities in the North or have to be shipped south.

> "In many instances, the recycling of wastes may not contribute as much toward a solution to environmental problems as widely supposed. Recycling can contribute significantly to pollution. Most important, recycling may use up more materials than it saves."
>
> (Mueller Associates, Inc., 1989)

7) * **Dust Control**

Although practised in other jurisdictions, road oiling with waste oil is not recommended in the NWT. Problems associated with road oiling are:

a) Contaminants can leach or run-off into nearby water bodies or ground water.

b) Puddles forming on or near roadways can be contaminated and pose a health threat to children playing in the area.

c) Contaminants can be carried on dust and inhaled or ingested (Epstein, Brown and Pope, 1982).

It is best to find other methods of dust control.

8) * **Open Burning**

When oil is burned in an uncontrolled manner, incomplete combustion occurs, resulting in particulates being released into the atmosphere. These particulates can be inhaled, ingested, or may contaminate water bodies or soil. Open burning is preferred over dumping or landfilling only if performed when the wind is in a direction to ensure that particulates are directed away from both the community and its water source.

9) * **Dumping into Sewers**

Oil dumped into sanitary sewers or pump-out tanks can kill the bacteria required for proper lagoon operation. Contaminants may also leach from a lagoon and taint ground water or nearby water bodies (Mueller Associates, Inc., 1989).

10) * **Indiscriminate Dumping or Landfill Disposal**

When waste oil is dumped on land or at waste disposal sites, constituents in the oil can contaminate soil, ground water or nearby water bodies. It can also pose health hazard to people or animals scavenging at the sites. Activity at dumps can spread contaminants throughout the community and nearby area. This is minimized if a separate used oil area is provided at landfill sites.

It must be remembered that degradation of waste oil in landfills is extremely slow. Uncontrolled landfilling of waste oil merely provides an inefficient method of storage of a potentially harmful waste.

Used Oil Collection

In smaller communities, monthly pick-up at the hamlet garage, DPW, power corporation, airport and local maintenance garage could collect the majority of the used oil generated in the community. The oil could also be collected at a tank located at the landfill site or another suitable location. This oil could then be disposed of by one of the methods described earlier. If the oil is to be used as a fuel or fuel supplement, care should be taken to avoid contamination by solvents, glycol or water.

In larger communities, pick-up should only be performed at large quantity generators. The remaining generators can be required to deposit used oil at larger establishments serviced by pick-up, or in tanks in one or more central locations.

In the South, experience has shown little success with requesting that used oil be dropped off at local garages and maintenance shops (Rippon, 1990, and Wenzler, 1990). Most garages did not appreciate the inconvenience of handling other peoples' used oil, especially if a fee for collection of this oil was charged by re-refiners. Many jurisdictions require a fee for dropping off used oil. This helps cover the cost of a collection facility, but also tends to dissuade people from using the service.

Used Oil Summary

1. Used oil has many hazardous constituents and must be treated as a hazardous waste.
2. Used oil can be disposed of economically and safely by burning in used oil furnaces, by blending with fuel oil (1:100) and burning in conventional boilers, or by sending south for re-refining.
3. Adequate methods of disposal are incineration, co-disposal, and re-refining or reprocessing.
4. Road oiling, open burning, dumping into sewers and

...ing in landfills or indiscriminate dumping are not recommended disposal methods.

18.2 Oil Filters

The hazards of oil filters are associated with the waste oil which they may contain. The survey revealed that there are 46,000 oil filters disposed of in the NWT each year. Of these:

- 62 % of oil filters are disposed of by open burning:
- 35% are landfilled;
- 2 % are stored; and
- 1 % are incinerated or sent out of the NWT for disposal.

1) * Drained and Rinsed**

Oil filters should be drained as well as possible, and preferably rinsed. The oil they contained should be disposed of by one of the methods recommended in section 18.1. Rinse water, if used, should be disposed of into a sewer system or sewage lagoon. Filters should not be rinsed until they are fully drained in order to avoid an excessive amount of oil in the rinse water.

2) * Co-disposal**

Drained oil filters can be deposited in co-disposal landfill sites. They should not be placed near the top or sides of the site and should be well dispersed throughout the domestic waste.

3) ** **Incineration**

Incineration of waste oil filters is one of the best methods of disposal. Unfortunately, it is costly and has little practicality in small isolated communities. See section 16.5 for more details on incineration in mobile or open pit units.

4) ** **Landfilled**

The hazards associated with the disposal of well-drained oil filters in landfills is not severe. They should be contained in thick plastic bags and large quantities should not be disposed of in one location. Filters should not be placed near the top, sides or bottom of the site.

5) ** **Open Burning**

Oil filters can be disposed of by uncontrolled burning. They may be burned with fuel or with municipal garbage during regular burning procedures.

18.3 Acid Batteries

The hazards of waste batteries are due to the sulphuric acid and lead which they contain. In municipal trash sulphuric acid poses an immediate hazard to garbage collectors, landfill workers, and peopel and animals scavenging at landfill sites (Schwartz and Pratt, 1990). At landfills, batteries are smashed or decay, releasing both lead and sulphuric acid into the soil. This results in a leachate which can contaminate groundwater with lead and acid.

The survey indicated that presently of the waste batteries generated in the NWT:

- 59 % are sent out of the NWT for disposal;
- 14% are disposed of in landfill/dump sites;
- 14% are stored;
- 12 % are recycled; and
- 1 % are burned.

1) *** **Recycling, Repair and Reuse**

This is the best way of disposing of old batteries. Battery recycling operations crack the batteries, extract the lead, smelt it and reuse it in the production of new batteries (Schwartz and Pratt, 1990). Depending on the current price of lead, sending spent batteries south to re-smelting operations may be economically viable (Municipality of Anchorage and Alaska Department on Environmental Conservation, 1986 and Technology Resource Inc., 1989).

Unfortunately, the battery recycling industry is highly concentrated within Canada. Approximately 90 % of the lead recycling capacity is centred in suburban Toronto and Montreal (Technology Resource Inc., 1989).

If batteries are sent south, the acid must be neutralized with lime. This resultant neutral pH liquid can be disposed of in sewage lagoons or sewers.

2) *** **Solidification**

Batteries can be solidified after the fluid has been removed and neutralized. Solidification fixes the lead within the battery shell thus decreasing the rate of leaching. The neutral or near neutral liquid can be disposed of in sewage lagoons or by solidification.

3) *** **Co-disposal**

Batteries can be disposed of in co-disposal sites. It is preferable to remove acid and neutralize it prior to disposal at the site. Care should be taken to ensure that the liquid is added at a rate that will allow it to be completely absorbed by the solid wastes at the site. It should be assumed that batteries, once emptied of acid, are 50 % lead by weight. Lead should be added at a rate that does not exceed 0.1 kg/tonne of domestic garbage.

4) ** **Neutralize and Dispose**

Battery acid must always be removed before disposal, neutralized with lime, and treated in a sewage lagoon. If no other maethod is available the dry cell can then be disposed of in a landfill site, preferably in a specific co-disposal site.

18.4 Anti-freeze (ethylene glycol)

Anti-freeze is composed of 30 % ethylene glycol, 70 % water and small amounts of metal contaminants (Schwartz and Pratt, 1990). It is poisonous, particularly to animals. Many pets die after drinking "sweet-tasting" puddles of anti-freeze on driveways, parking lots or sidewalks (The Municipality of Anchorage and Alaska Department of Environmental Conservation).

In the NWT anti-freeze is

- stored;
- disposed of in landfills;
- mixed with waste oil and disposed of with it;
- dumped in sewer or sewage lagoon; or
- used for dust control.

Some industries dispose of waste glycol by incineration, injection, recycling, discharging into the ocean or evaporation.

1) ***** Recycling and Reuse**

Anti-freeze can be vacuum distilled and reused (Schwartz and Pratt, 1990). This is an extensive process and only economically feasible for generators of large quantities of waste anti-freeze. On a smaller scale, it is sometimes possible to filter particulates from anti-freeze and reuse it (Raymond, 1990).

2) ***** Incineration**

Ideally, when not recycled or reused, anti-freeze should be incinerated at a high temperature. Applicable technology is described in section 16.5.

3) ***** Sent South**

Anti-freeze can also be sent south for recycling. This is an expensive practice but is sometimes the most economical proper solution.

4) ***** Co-disposal**

Anti-freeze can be disposed of at a designated co-disposal landfill site (see section 16.2). Care should be taken to ensure that liquid is added at a rate that allows it to be totally absorbed by the domestic garbage at the site.

(5) **** Dumped in Sewers or Sewage Lagoons**

Small quantities of antifreeze (less than 5 L) can be diluted with large quantities of water and dumped into the sewer system (if available) or dumped into sewage lagoons (when sufficiently diluted).

6) **** Evaporation**

Small quantities of glycol can be disposed of by evaporation. This must be done in an adequately ventilated location, preferably outside, away from animals or children. The residue should be properly disposed of.

7) *** Solidification**

Solidification is not recommended because glycol may impede setting or escape as a vapour.

8) *** Landfilling**

Glycol must not be dumped in landfill sites or other solid wastes disposal sites.

9) ***** Anti-freeze Containers**

Empty anti-freeze containers should be rinsed with water and the rinse water dumped into sewers or sewage lagoons. These containers can then safely be disposed of at a landfill site.

18.5 Spent Solvents

Solvents are chemicals used for thinning, degreasing, cleaning and stripping. Some common solvents are listed in

Table 18-7.

TABLE 18-7
COMMONLY USED SOLVENTS

Mineral Spirits	Turpentine
Acetone	Isopropanol
Petroleum Distallates	Varsol
Methanol	Naptha
Toluene	Chloroform
Methyl ethyl Ketone (MEK)	Kerosene

Source: Technology Resources Inc., 1989.

Solvents can be extremely toxic to people and animals. Some solvents are carcinogenic and some are combustible. When handling spent solvents, contact with the skin and the breathing of fumes should be avoided.

The survey revealed that there are 58,000 L of solvents and organic solutions generated each year in the NWT. This comprises 2 % of the hazardous wastes in the NWT. Also, 34 % of NWT household hazardous wastes are cleaners and solvents.

Many methods are used to dispose of solvents in the NWT:

- 75 % are stored on-site;
- 13 % are disposed of in landfill sites;
- 5 % are burned;
- 3 % are burned for heat;
- the remaining 4 % are incinerated, used for dust suppression or disposed of in sewers.

1) ***** Waste Minimization**

Although spent solvent generation cannot be totally eliminated and some final disposal will be required, waste minimization should be implemented. Significant reductions of spent solvent can be achieved by the proper operation of existing equipment and good housekeeping efforts.

Some practical waste solvent minimization suggestions are to:

- properly locate equipment to simplify operations and prevent spills;
- install cleaning tanks and operate them properly. solvent sinks, to collect and reuse spent solvents, have been proven efficient in reducing waste (Toy, 1988);
- avoid cross-contamination of solvents;
- avoid water contamination of solvents;
- remove sludge continuously;
- in paint stripping operations, replace solvents with plastic bead blasting (when applicable); (Batstone, Smith and Wilson, 1989a)
- replace solvent-based cleaning systems with detergent cleaning systems if possible. Detergent cleaning systems can be an attractive alternative and the waste can usually be discharged to sewer systems .
- pre-clean heavily contaminated parts with detergent prior to the solvent cleaning step. This can significantly extend solvent life; and
- allow pieces to dry before cleaning with solvent. This can prevent water contamination of solvent. When properly operated, most solvent cleaning systems should only require solvent replacement when oil/grease concentration becomes too high. (Hazelwood and Burgher, 1985).

2) *** **Solvent Recovery**

Small scale on-site solvent reclamation equipment is becoming increasingly available. These units are ideal for businesses/industries which generate at least 200 L of spent solvents each month. Under these circumstances, installation of the units has been found to have a payback period of 2-3 years (Kaminski, 1988).

Few recovered or reclaimed solvents actually meet their original specifications, but they can be used in non-critical operations or blended with new material.

3) *** **Incineration**

Non-combustible organic solvents should be incinerated in special high-temperature incinerators. See section 16.5 for details on incineration. During incineration hydrochloric acid gas may be formed and scrubbing equipment should be in place to remove it (Batstone, Smith and Wilson, 1989b). Combustible organic solvents can be disposed of by less expensive methods, although incineration would be also be the best method.

4) *** **Burned as a Fuel**

When diluted with new fuel oil, certain spent solvents can be burned in conventional boilers as fuel. If this is done, care must be taken to ensure that toxic organic solvents are not mixed with solvents that can be used for fuel (National Association of College and University Business Officers, 1987).

5) ** **Open Burning**

Combustible organic solvents (those that burn unsupported at 40°C or below) are frequently toxic and their vapours can be explosive when mixed with air. When other disposal methods are not possible, open burning of combustible organic solvents is the most appropriate method of disposal (Batstone, Smith and Wilson, 1989b). As with other wastes, combustion should be performed an adequate distance away from both the community, with the prevailing wind directing smoke away from the community and water supply.

Non-combustible organic solvents should not be burned except in an incinerator.

6) **** Co-disposal**

Non-combustible solvents can be landfilled in small quantities (Batstone, Smith and Wilson, 1989b). They should be well contained and disposed of in a manner which will allow attenuation by domestic refuse, and gradual degradation when the contents do eventually escape.

Combustible organic solvents should not be landfilled.

7) **** Evaporation**

About a third of the organic solvents purchased evaporate during storage and use, and disperse to the atmosphere. Controlled evaporation can be used for waste disposal of some solvents but should be done only with adequate ventilation. Fire prevention must also be considered, since an open solvent container may be highly flammable (National Association of Colleges and University Business Officers, 1987).

8) *** Solidification**

Solidification is not very successful with solvents because they impede setting and escape as vapour.

9) * **Sewers**

Solvents should not be dumped into sewers or sewage lagoons.

10) * **Dust Suppression**

As with waste oil, spent solvents should not be applied to roads or parking lots for dust suppression purposes. The hazards involved with this practice are described in Section 18.1.

11) *** **Rags Containing Solvents**

Rags containing solvents should be air-dried in a well ventilated location. They can then be disposed of at a landfill site (Municipality of Anchorage and the Alaska Department of Environmental Conservation, 1986).

18.6 Waste Paints

Latex paints are not considered toxic. Oil-based paints, lacquers, enamels and sealers are toxic to people and animals because of the solvents they contain. Some older paints contain mercury, lead or PCB's.

In the NWT discarded paint comprises a large percentage of the waste collected on household hazardous waste collection days. Excluding household hazardous wastes, 33,000 L of paint and organic residuals are disposed of each year in the NWT. Disposal methods employed for waste paint are as follows:

- 65 % is disposed of in landfills/dumps;
- 19 % is incinerated; and
- 16 % is burned in an uncontrolled manner.

1) *** **Recycling**

Eighty percent of collected oil and latex paint can be recycled. In Ontario it is expected that recycled paint will be on the market by 1992 (Marsales, 1990). Waste paints can be sorted (latex/oil) and blended to produce a homogeneous dove white or grey paint. This paint can be tinted grey or red. This will not result in a high quality paint but can be used as a low cost primer.

2) *** **Waste Minimization**

For large paint application operations there are several methods of minimizing waste paint such as:

- using equipment with low overspray;
- inspecting all equipment parts before painting; and
- using equipment with high transfer efficiency

(Batstone, Smith and Wilson, 1989a).

Table 18-8 demonstrates how a change in equipment may increase the transfer efficiency.

TABLE 18-8
PAINTING EQUIPMENT AND TRANSFER EFFICIENCIES

Paint Transfer Methods	**Transfer Efficiency (% Applied)**
Air-atomized, conventional	30-60
Pressure-atomized, conventional	65-70
Air-atomized, electrostatic	65-85
Centrifugally-atomized, electrostatic	85-95
Roll coating	90-98
Electrocoating	90-99
Powder Coating	90-99

Source: Regan, 1985.

3) ** **Co-disposal**

Co-disposal of oil paint at a designated site can be an acceptable method of disposal, provided that the paint is applied at a rate that allows all the liquid to be absorbed into the domestic waste at the site (Batstone, Smith and Wilson, 1989b).

4) ** **Landfilling**

Latex paints can be safely disposed of in landfills. Before disposal, any liquid present should be absorbed by adding sawdust, soil or lichen. Containers should then be sealed and placed in landfills. Oil paints should not be disposed of in landfill sites (The Alaska Department of Environmental Conservation, 1986).

5) ** **Painting**

Paint is least hazardous after it is applied and has polymerized. The drying of paint is a crude means of solidification which fixes the hazardous constituents within the solid matrix. Therefore, if there is something to paint, it is recommended that it be painted. Waste paint can be disposed of by painting surfaces of solidified or encapsulated wastes thus helping to further encapsulate the wastes, while disposing of the paint.

6) *** **Paint Containers and Material Used For Clean-up**

Both latex and oil paint containers and clean-up materials can be disposed of in landfill sites. Before disposal, empty or nearly empty containers of paint should be air-dried in a well-ventilated area (preferably outside) away from the reach of children or animals. Rags and other materials used for clean-up should also be air dried prior to disposal at landfills.

If the recycling of paint is practised, waste paint containers can be reused for this purpose.

7) * **Sewer**

Latex or oil paint should not be dumped into sewers or sewage lagoons.

18.7 Asbestos

Asbestos is a fibrous material used primarily as an insulating material. Typical asbestos fibres are not visible to the human eye but can become suspended in air for many hours and can cause asbestosis or cancer if inhaled (Allegri, 1986).

Asbestos is an insulating material which can withstand high temperatures. In the past, it was often used for insulation in schools and other public buildings. Concern about the material has resulted in its removal from many facilities. When asbestos is sealed in a confined area (e.g. above ceiling tiles) it poses no threat. It is only harmful when the fibres are liberated into the air (e.g. during handling, removal, demolition and disposal practices).

If asbestos is in use in a sealed environment it is recommended that it be left alone. If it has already been removed or is not securely sealed precaution must be taken during disposal to ensure that personnel do not inhale the fibres. The NWT "Asbestos Disposal Guidelines" (Department of Renewable Resources, 1990b) recommend that these steps be followed when handling asbestos:

1. Contact the Pollution Control Division of the Department of Renewable Resources for approval to dispose of waste asbestos (403) 873-7654 in Yellowknife.
2. Contact the Occupational Health and Safety Division of the Department of Safety and Public Services for worker safety requirements, handling and packaging procedures (403) 873-7468 in Yellowknife.
3. Contact the TDG Office of the Department of Transport for the request to transport waste asbestos to a disposal, storage or treatment facility (403) 874-6972 in Hay River.

The following are suggested disposal practices:

1) *** **Solidification**

Solidification with cement is an excellent technology for the disposal of asbestos because it permanently prevents asbestos fibres from being dispersed into the atmosphere (Batstone, Smith and Wilson, 1989b).

2) *** **Burial**

Asbestos must be secured to prevent environmental dispersion of the mineral fibres. Burial at an approved site is a good method of disposal provided that it is contained and that the containers are not ruptured during handling. Final deposition should be under at least 1 m of cover soils. Records should be kept of the amount and location of the asbestos and signs posted to prevent future disruption.

3) ** **Landfilling**

The landfilling of asbestos requires particular care. It should be disposed of in strong plastic bags or sealed drums. At least 0.5 m of other suitable waste must immediately be spread over the bagged asbestos. An additional 1.5 m should be placed on top so that the waste does not lie within the top 2 m of the site. Records should be kept on the quantity and location of the waste to avoid future disruption.

18.8 Tank Sludges and Heavy Tars

Tank sludges are the sediments which accumulate at the bottom of fuel tanks. There are 60,000 L of tank sludges generated in the NWT each year. This is approximately 3 % of the total quantity of hazardous wastes. These sludges may contain hazardous components and should be disposed of appropriately.

Currently the most common method of disposing of tank sludges in the NWT is open burning. Other methods revealed by the survey are landfilling, incineration, storage, treatment in tailings ponds, sending out of the NWT, landfarming and recycling.

1) *** **Incineration**

High temperature incineration is the best method of disposing of tars and sludges. Open pit incineration as described in section 16.5 has been successfully used for these types of wastes (Batstone, Smith and Wilson, 1989c).

2) ** **Co-disposal**

Tars and sludges can also be deposited in a co-disposal landfill site. Loading rates should not exceed 40 kg/tonne of refuse.

3) * **Open Burning**

Open burning of sludges and tars should only be practised as a last resort. It should be conducted a sufficient distance from communities when the wind is directed away from both community and water supply.

18.9 Drummed Wastes

Drummed wastes consist of empty, partially filled or full drums. In many communities drummed wastes comprise a large portion of bulky wastes. These wastes present a big problem in the North and can be hazardous depending on the contents or former contents.

In the NWT, businesses, industries, and communities generating contaminated containers identified landfilling as the most commonly employed disposal method. Other methods employed are recycling, burning, sending south, and storing.

As a general principle, drummed wastes are unacceptable at landfill sites. Large quantities of drums pose stability problems when landfilled because it is impossible to eliminate all void space between the drums. Drums eventually corrode and release their contents (Batstone, Smith and Wilson, 1989b).

Although drums can contain a variety of wastes which would require a variety of different treatment methods the following are a few disposal suggestions for general drummed wastes.

1) *** **Returned to Supplier**

Whenever possible, empty drums should be returned to the supplier. Many times a deposit may be associated with the container, making this an economical option.

2) *** **Used to Solidify Hazardous Wastes In**

If the in-drum method of solidification of hazardous wastes is employed (see Section 16.3), drums are filled with a solid waste/concrete matrix and then discarded.

3) ** **Landfilling**

"In exceptional circumstances... the landfilling of waste packaged in drums is the best practical environmental option" (Batstone, Smith, and Wilson, 1989b). Certain guidelines should be followed when landfilling drums:

1. Only full drums of solid wastes should be landfilled. The drums should be carefully labelled by the generator.

2. It is recommended that when drummed waste are accepted at a site, there should be a designated drum reception storage area. This area can be used to inspect drums prior to disposal.

3. Records of where drummed wastes are located at the site should be kept.

4. Full or partially full drums should not be deposited in landfills where open burning is practised.

5. Drums should be spaced out throughout the landfill at intervals of not less than 0.5 m and immediately completely surrounded and covered with domestic waste or other cover.

6. Drums containing liquid waste should be emptied and the contents disposed of properly. If the liquid is not hazardous, it can be disposed of at the landfill if the liquid loading rate of the domestic waste is not exceeded.

7. Empty drums, if not reused, should be crushed and landfilled. Reuse of drums that have contained dangerous waste is not recommended. If possible these drums should be rinsed and the rinse water placed in sewage lagoons.
(Batstone, Smith and Wilson, 1989b).

4) ** **Storage**

If drummed wastes are stored intact, they should be stored in a manner that does not allow incompatible wastes to mix if leaking should occur (see Figure 16-1). The drums should be surrounded by berms to contain any leaks and should be routinely inspected. If any leak does occur, the area should be pumped out immediately. Berms are only intended to contain liquids for a short time, not indefinitely.

18.10 Gas Cylinders

Gas cylinders referred to here are small portable containers including those which contain propane. Recent incidents in northern communities have emphasized the importance of safe disposal of empty gas cylinders. Youths have been injured or killed by the misuse of the contents in discarded cylinders. Cylinders or bottles containing propane or other gases can explode when heated, punctured, or crushed (The Municipality of Anchorage and the Alaska Department of Environmental Conservation, 1986). It is essential that the practice of indiscriminately discarding "empty" cylinders be discontinued.

There are 1,000 waste gas cylinders generated each year in the NWT. Generators of waste gas cylinders in the NWT identified the following as methods used to disposed of the cylinders.

- 78 % of the cylinders were sent out of the NWT,
- 14 % were reused;
- 4 % were stored; and
- 4 % were landfilled.

1) ***** Return to Dealer**

Empty gas cylinders are valuable and should be returned to the manufacturer. Before pick-up, cylinders should be securely stored in a manner that will not allow public access and misuse.

2) **** Landfilling**

If it is impossible for cylinders to be reused and returned, they must be <u>totally</u> emptied and the valves removed prior to disposal. There should be absolutely no pressure left in the cylinder. At the landfill they should be dispersed with municipal garbage and not allowed to accumulate in one location.

3) **Storage**

While empty cylinders are in storage awaiting pick-up, they should be stored in a manner that does not allow misuse.

18.11 Bulky Wastes

Bulky wastes are large items which do not degrade quickly in the environment. Examples of bulky wastes are drums and gas cylinders (described in the previous two sections), discarded vehicles and appliances, metal wastes and construction wastes.

There are no quick, easy solutions for the disposal of bulky wastes in the NWT. In most communities, bulky wastes have accumulated to such an extent that crushing and shipping south or burying are the only solutions. Shipping south can be relatively inexpensive for communities accessible by barge, particularly in areas where burial is expensive. Some barge companies will ship scrap south at reduced rates rather than return south empty.

The hamlet of Cape Dorset recently performed a feasibility study on a project to scrt, bale and ship bulky wastes south The project would consist of renting a large capacity baler, buying manoeuvring equipment and using local labour to segregate, crush and ship the scrap south. If the equipment were leap-frogged from community to community in the Baffin and Keewatin regions, the cost would be significantly reduced, thus making it economically feasible (Gilhoulie, 1990).

In Iqaluit, bulky wastes are now left exposed at several locations where they were previously buried (Collings, 1990). If bulky wastes are buried, it needs to be done in manner that will avoid future exposure and disruption of permafrost.

18.12 Household Hazardous Wastes (HHW)

Finnecy (1988) states that:

> "By any objective standard household waste is a 'hazardous waste' by virtue of its potential to pollute water. The fact that most countries choose to exclude it from their lists of hazardous waste is a political decision that has very little, if any, basis in science. Many so-called 'hazardous wastes' have less potential to pollute water than does household waste."

Any consumer product carrying a label warning of flammable, toxic or corrosive contents contributes to the hazardous nature of household waste. Examples are listed in Table 18-9.

TABLE 18-9
TYPICAL HOUSEHOLD HAZARDOUS WASTES

All-purpose Cleaners	Anti-freeze
Ammonia	Car Batteries
Disinfectants	Used Oil
Drain and Oven Cleaners	Brake Fluid
Silver and Brass Polish	Transmission Fluid
Hair Dyes, Perms and Sprays	Windshield Washer
Nail Polish and Remover	Glues
Toilet Bowl Cleaners	Paints
Unused Medicine	Solvents
Pesticides and Herbicides	Ammunition

In Ontario, 70 % of HHW collected are paints, thinners and coatings. An additional 16 % are oils and batteries (Marsales, 1990). This study revealed that about 3.0 kg of HHW are generated by each person in the NWT each year. This amounts to approximately 119,000 kg throughout the NWT each year (5 % of the NWT's hazardous waste stream).

The key to management of these wastes is public education. The reasons household hazardous wastes are improperly disposed of are that:

- people do not realize the waste is hazardous;
- people do not know the proper way to dispose of the waste; or
- no proper disposal options are available.

The first two of these problems can be solved by public education. Public education can also minimize the amount of hazardous wastes generated, thus reducing the cost of solving the third problem.

1) *** **Waste Minimization**

Included in Appendix E are some HHW minimization methods. Waste minimization is the best and most inexpensive method of dealing with HHW wastes. If the amount of hazardous components in these wastes is decreased, then their hazardous nature can be significantly reduced.

2) *** **Household and Small Quantity Generator Hazardous Waste Collection Centres**

Hazardous waste collection centres are supervised locations where individuals and small businesses can deposit hazardous wastes for a fee. Presently there is already one in the North, operating in Anchorage, Alaska. Refer to section 17.2 for details on that collection centre.

3) ** **Household Hazardous Waste Collection Days**

Many communities in Canada participate in regular "household hazardous waste days". These "HHW days" are designed to collect hazardous wastes which are stored or generated in households and will eventually end up at municipal landfills or in sewer systems. It is estimated that in Ontario, 2-7 % of the household hazardous wastes generated are collected on "HHW days" (Patterson, 1990).

HHW days are also operating in several communities in the NWT. Hazardous wastes collected on the household hazardous waste day in Yellowknife in October 1989 are shown in Table 18-10. The wastes were similar to those collected in Ontario, with about 60 % consisting of paints, and 25 % of batteries and used oil.

TABLE 18-10
HOUSEHOLD HAZARDOUS WASTES COLLECTED
IN YELLOWKNIFE, OCTOBER 14, 1989

Item	Litres	kg	%*
Pesticides (Toxic and Flammable)	13.4	6.6	1.4
Compressed Gases (Flammable)	3.8	0.015	0.3
Alkalis	39.1	10.5	3.5
Flammable Liquids (Poisonous)	70	---	4.9
Acids (Non-oxidizing)	3	2.5	0.4
Acid Filled Batteries	112	---	7.8
Used Motor Oil/Fuel Oil	250	---	17.4
Unknown Items	7	1	0.6
Paint (Latex, Oil)	890	---	62.0
Items Not Categorized	20	5	1.7
Total	**1410**	**26**	**100**

* based on a density of 1 g/cm^3
Source: Department of Renewable Resources, 1989b.

Although household hazardous waste days collect some wastes and arouse public interest in hazardous waste disposal, they do not solve the problem. In some cases they may encourage people to store hazardous wastes in their homes while waiting for the next collection day. Few programs encompass more than 1 % of the households in the community, and operational costs are exceedingly high (Technology Resource Inc., 1989).

> " ...no one can disagree with statements to the effect that it is desirable to avoid having any hazardous waste in the municipal waste stream. However, when cost-benefits are applied to participant levels and volumes of household wastes, they hardly justify the enormous expense incurred. It is through publicity and the educational activities that accompany these programs, the average citizen can draw the link between the waste produced by a chemical factory and the wastes stored in the household. Both are dangerous and require special handling and solutions for safe disposal."
>
> (Technology Resource Inc., 1989)

The main benefit provided by "HHW days" is public education. Real solutions to hazardous wastes lie in waste minimization and public education.

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PART IV

CHAPTER 19

RECOMMENDATIONS

The following are recommendations for future work to be done in the area of hazardous wastes in the NWT. These needs were revealed while performing this study. The recommendations will be discussed individually and summarized at the end of the chapter.

Recommendation 1: Perform Feasibility Studies on Central Hazardous Waste Facilities in Several of the Larger Communities in the NWT.

The disposal options provided in Part III are meant only as interim solutions to control pollution problems now. More is needed in the future. Studies should be performed now to prepare for facilities which may be required later. A hazardous waste management study in Thailand stated its intention as "...to get over the present industrial pollution problems as well as to prepare a good plan to match future needs." (Lohwongwatana, Soponkanaporn, and Sophonsridsuk, 1990) This would be an excellent goal to adopt in the NWT.

"Even in the long term, there will be a need to develop solutions which are compatible with the limited resources available." (Batstone, Smith and Wilson, 1989a) In keeping with this, it is recommended that in-depth studies be performed on the following hazardous waste treatment facilities:

- co-disposal sites (for domestic and hazardous wastes, see section 16.2);
- open-pit incineration (see section 16.5);
- mobile incineration (see section 16.5); and
- hazardous waste collection centres (see section 17.2).

These studies should include capital and operation cost estimates and expected time required for design, construction and start-up of these facilities.

These types of facilities should be considered for major centres, such as:

- Yellowknife;
- Hay River;
- Inuvik;
- Rankin Inlet; and
- Iqaluit.

Central facilities should be considered, if practical, to minimize pollution control costs (Chiu and Tsang, 1990). This cost reduction must be weighed against the increased cost of transportation to central facilities.

Wilson and Balkau (1990) stress the need to "develop facilities simultaneously with regulations". This leads to recommendation number two.

Recommendation 2: Establish Clear Government Regulations and Strict Enforcement

> "Environmental pollution cannot easily be dealt with unless the government introduces proper legislation and imposes suitable sanctions against polluters"
> (Lohwongwatana, Soponkanaporn and Sophonsridsuk, 1990)

In general, if hazardous waste regulations are clear and enforced, large industries will find proper disposal methods. Many industries are now trying to implement safe environmental control. Industries which do not practice proper hazardous waste management techniques have a financial advantage, at least in the short-term, over environmentally conscientious businesses. Fines for improper disposal would improve this situation. Proper hazardous waste disposal should be rewarded rather than punished.

Zeiss (1989) states it as follows:

> "All generators may agree to uphold the same standards with the same resulting costs. Thus, the hazardous waste policy affects all firms roughly equally. In contrast, the large number and low conscientiousness of small firms allows for much variation in the level of hazardous waste management effort. Hence, there is a disincentive for a small generator to go beyond a very basic level of emission control and waste treatment for fear she or he will be the only one to incur extra costs. This would not occur if enforcement were strict and consistent for all generators large and small alike."

It is very important that hazardous wastes management regulations be fair to all. "Firms will comply with regulations and accept extra costs more readily if the regulations and their enforcement are considered fair to all waste generators" (Zeiss, 1989).

Recommendation 3: Provide Government Incentive (Financial or Otherwise) for Businesses/Industries/Communities to Install Waste Oil Burning Furnaces

According to Wilson and Balkau (1990) one of the guiding principles of starting a successful hazardous waste management system is:

> "It will in most cases be necessary to use both 'carrot' and 'stick'. A combination of punitive and supportive actions is more likely to be effective than either method on its own. Legislation will prescribe (and proscribe) certain actions, providing a 'stick'. However, at least initially, it is advisable also to show support for industry by providing a 'carrot'. This could be by subsidizing treatment costs, or financially supporting waste minimization by for example, providing free technical advisory services, operating a waste exchange and/or publishing a technical handbook."

Programs such as these are necessary because very often businesses will not be able to bear the initial expense of installing a waste oil burning furnace. In the long-term there are usually financial benefits, but they cannot be realized if the initial capital is not available. Government incentives must be provided if use of this equipment is to become wide-spread.

Recommendation 4: Perform a Detailed Feasibility Study on the Disposal of Accumulated Bulky Wastes (by Shipping South or Burying) in Isolated Communities

Bulky wastes, which have accumulated in northern communities can be hazardous, may pose a safety risk and are unsightly. Their removal or disposal is essential in many municipalities. Often these wastes have a monetary value as scrap, which could help to off-set the cost of shipping south for disposal. Recently, a feasibility study was performed on a project in Cape Dorset to send bulky wastes south (see section 18.11). In some locations, burial may be a more appropriate method of disposal.

Recommendation 5: Develop a Waste Minimization Plan for Industries Businesses, and Municipalities and Provide Government Incentive for the Establishment of these Programs

The waste minimization suggestions offered in this report can only give a general outline of these techniques. For serious improvements to be made in this area, a more detailed plan must be offered. Above all, "The most important requisite for waste minimization is active enforcement of air and water pollution control and hazardous waste management regulations." (Batstone, Smith and Wilson, 1989a)

As with the installation of waste oil furnaces, waste minimization programs usually result in long-term finacial benefits. Unfortunately, in many cases, the initial capital cost of these programs may prevent their establishment. Government incentives may help get these programs started. This in turn, will decrease municipal solid waste disposal costs.

Recommendation 6: Develop Safe Methods of Recovering Reusable Items from the Waste Stream.

As the saying goes:

"One person's garbage is another person's gold."

It has been the trend in "developed" countries to take this "gold", put a fence around it, and bury it. Scavenging from open-dump sites is almost universally opposed in industrialized countries, primarily because of potential liability claims and public health hazards (Kungskulniti, 1990). Even so, scavenging serves an important purpose by recycling and reusing discarded items, thus reducing the volume of the waste stream. A report on the status of the landfill site in Yellowknife (Environment Canada, 1985) states:

> "A considerable number of patrons haul and deposit their own wastes as well as scavenge and recycle previously discarded refuse. These scavengers recycle material from the landfill to such a degree that the City feels that 'on some days deposits and withdrawals are roughly equal'."

Scavenging is beneficial except for the detrimental health effects to those people performing it. Kungskulniti (1990) states that:

> "Better methods of retrieving recyclable materials and disposing of wastes should be developed. This means assisting the scavengers to work in improved facilities and in an improved environment."

This may be solved by setting aside an area at landfill sites where potentially reusable items can be dropped off and retrieved. Another option is to conduct periodic "retrievable garbage days" where items are set out on the curb not for pick-up but for reuse by others.

Recommendation 7: Start a Program of Public Education, Emphasizing Household Hazardous Wastes, Small Quantity Generator Hazardous Wastes and Hazardous Waste Disposal Facilities

> "Without public education on the issues, and a general awareness of the dangers of improper disposal of hazardous waste, there is too often insufficient public demand for action."
> (Batstone, Smith and Wilson, 1989a)

Public education should be started as soon as possible. This process has already begun by the distribution of the hazardous waste questionnaire and the use of household hazardous wastes collection days in some communities. Ninety percent of the questionnaires returned had been re-stapled after removal of the section containing the definition of hazardous wastes. This could indicate that businesses, industries and municipalities wanted to retain a copy of the definition. "People who perceive a waste as dangerous (e.g. cyanide) are more likely to dispose of it legally than if they perceive the waste as relatively innocuous (e.g. oily waste water, anti-freeze) (Schwartz and Pratt, 1990).

A suggestion made by Wilson and Balkau (1990) is to:

> "Commence very early with public and decision maker awareness and education... The initial expenditure should perhaps be to identify and publicize the problem so as to build support, in principle, for some type of action."

There are a series of "fact sheets" available from:

Conservation and Protection
Environment Canada
Ottawa, Ont.
K1A 0E7

These may be helpful in the educating process, although pamphlets specific to the NWT may be more appropriate.

Wilson and Balkau (1990) also suggest that initial public education should centre on explaining the situation to journalists, politicians and NGO's (non-government organizations). If hazardous waste management facilities are to be sited within the next 20 years, public education in this area should be started now. The problem with hazardous waste facility siting is that people are afraid of the unknown.

> "Unfamiliar risks are less acceptable than familiar risks. The most underestimated risks are those, such as household accidents, that people have faced for long periods without experiencing the undesirable event...Thus, the perceived riskiness of a hazardous waste facility is, in part, a reflection of its unfamiliarity. Stressing its similarity to more familiar industrial facilities can diminish the fear; so can films, tours and other approaches aimed at making the facility seem less alien. Even more important is to make the waste to be treated seem less alien. Detailed information on the expected waste stream - what it is, where it comes from and what it was used to make - should reduce the fear level considerably."
> (Sandman, 1986)

In the NWT, very few of the hazardous wastes generated are exotic, little known chemicals. Most are regular, everyday wastes which people deal with sometime in their life. If the public are made aware of this fact, hazardous waste facilities should be less difficult to site.

> "When people are treated with fairness and honesty and respect for their right to make their own decisions, they are a lot less likely to overestimate small hazards."
>
> (Sandman, 1987)

Public education serves two purposes:

- increase the awareness of hazardous wastes generated at home, businesses, and municipalities; and
- decrease the fear associated with the disposal of these wastes.

19.1 Summary of Recommendations

1. Perform feasibility studies on central hazardous waste facilities in several of the larger communities in the NWT.

2. Establish clear government regulations and strict enforcement.

3. Provide government incentive (financial or otherwise) for businesses/industries/communities to install waste oil burning furnaces.

4. Perform a detailed feasibility study on the disposal of accumulated bulky wastes (by shipping south or burying) in isolated communities.

5. Develop a waste minimization plan for industries businesses, and municipalities and provide government incentive for the establishment of these programs.

6. Develop safe methods of recovering reusable items from the waste stream.

7. Start a program of public education, emphasizing household hazardous wastes, small quantity generator hazardous wastes and hazardous waste disposal facilities.

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APPENDIX A

GLOSSARY OF TERMS

Taken in part from: Batstone, Smith and Wilson, 1989, and Scanlon, 1987 Smith, 1986

Active layer. The layer of soil which freezes and thaws annually as seasons change.

Air pollution. The presence of contaminant substances in the air that disperse improperly and interfere with human health.

Arctic. Regions where no mean monthly temperature is greater than 10 C and where at least one month has a mean monthly temperature of 0 C or colder.

Background level. The level of pollutants present in soil, air or water from natural sources in a particular region.

Berm. A ledge or shoulder constructed around an area to contain a spill.

Biodegradable. Any substance that decomposes quickly through the action of micro-organisms.

Biodegradation. The destruction of organic materials by micro-organisms, soils, natural bodies of water or wastewater treatment systems.

Bulky Wastes. Waste articles which are cumbersome to handle and dispose of.

Carcinogen. A substance or agent producing or inciting cancer.

Co-disposal. The intentional and controlled disposal of hazardous wastes with domestic wastes.

Combustion. Burning, or rapid oxidation accompanied by release of energy in the form of heat and light.

Continuous permafrost. An area underlaid by permafrost with no thawed areas except under large lakes and rivers that never freeze solid.

Cover Material. Soil, rock, snow or waste material used to cover solid wastes in a landfill site.

Decomposition. The breakdown of matter by bacteria. It changes the chemical make-up and physical appearance of materials.

Deep-well injection. Discharge of wastewater through a properly designed well. Well depth may range from a few hundred to several thousand feet.

Dike. An embankment constructed around an area to contain a spill.

Dilution. Disposal of liquid wastes by discharge to and dispersion in receiving water or other liquid medium, with resulting reduction in concentration of constituents.

Discontinuous permafrost. An area underlain mostly by permafrost but containing small areas of unfrozen ground, such as on south-facing slopes.

Domestic wastes. Wastes originating from households, municipalities and businesses not industries.

Drilling mud. Fluid used in the oil industry to flush away broken rock, and lubricate the bit.
Dump. A site used to dispose of solid wastes without environmental controls.
Effluent. Waste material discharged into the environment. It can be treated or untreated.
Encapsulation. The containing of hazardous wastes into a solid vault.
Environment. The sum of all external conditions affecting the life, development and survival of an organism.
Flue gas. The air coming out of a chimney after combustion. It can include nitrogen oxides, carbon oxides, water vapour, sulphur oxides, particles, and many chemical pollutants.
Fly ash. Noncombustible particles carried by flue gas.
Groundwater. The supply of fresh water under the Earth's surface that forms a natural reservoir.
Hazardous waste. Waste materials which by their nature are inherently dangerous to handle or dispose of.
Honey-bag. A bag containing raw human sewage from individual homes. It fits inside a bucket toilet.
Incineration. Combustion or controlled burning of volatile organic matter in sludge and solid waste, which reduces the volume of the material while producing heat, dry inorganic ash, and gaseous emissions.
Incinerator. A controlled chamber where waste substances are burned.
Inert. Substances which do not react with other substances under ordinary conditions.
Infiltration. The action of water moving through small openings in the earth as it seeps down into the groundwater.
Infrastructures. Permanent installations and facilities belonging to a community including roadways.
Lagoon. A shallow pond where sunlight, bacterial action, and oxygen work to purify wastewater.
Land farm. Application of raw or treated wastewater sludges, or solid waste to soils without production of usable agricultural products.
Landfill. A controlled site used to dispose of solid wastes.
Leachate. Polluted water after it has seeped through solid wastes.
Leaching. The process by which nutrient chemicals or contaminants are dissolved and carried away by waster or are moved into a lower layer of soil.
Mobile Incinerator. A portable incinerator used for the destruction of hazardous wastes.
Monitoring. Periodic or continuous sampling to determine the level of pollution or radioactivity.
Organic. Any chemical compound containing carbon. Some simple compounds are excluded such as carbon dioxide and carbon monoxide.
Outfall. The place where an effluent is discharged into receiving waters.

Overfire air. Air forced into the top of an incinerator to fan the flame.

Oxidation. Oxygen combining with other elements.

Particulates. Fine liquid or solid particles such as dust, smoke, mist, fumes or smog, found in the air.

Pathogenic. Capable of causing disease. This is characteristic of biomedical wastes, dead animals and honey bag sewage.

Permafrost. Soil, bedrock, or other material that has remained below 0 C for two or more years.

Pesticide. Any substance used to control pests ranging from rats, weeds, and insects to algae and fungi. Pesticides can accumulated in the food chain and can contaminate the environment if misused.

pH. A measure of the acidity or alkalinity of a material, liquid or solid. pH is represented on a scale of 0 to 14 with 7 being a neutral state, 0 most acid, and 14 most alkaline (basic).

Pit privy. A privy placed directly over an excavation in the ground. Also called an outhouse.

Pollutant. Any introduced substance that adversely affects the usefulness of a resource.

Pollution. The presence of matter or energy whose nature, location or quantity produces undesired environmental effects.

Pump out sewage. Sewage resulting from buildings serviced by water and sewage holding tanks.

Receiving waters. Any body of water where untreated wastes are dumped.

Recycling. Converting solid waste into new products by using the resources contained in discarded materials.

Remediation. The act of cleaning up a site which has been polluted.

Runoff. Water from rain, snow or irrigation that flows over the ground surface and returns to water bodies. It can collect pollutants from air or land and carry them to receiving waters.

Sanitary landfill. A completely engineered, and monitored landfill site where wastes are spread in thin layers, compacted by heavy machinery and covered with soil daily.

Scrubber. An air pollution control device that uses a spray of water to trap pollutants and control emissions.

Septic. Used to describe a water body that has no oxygen present.

Sewage. Household and commercial wastewater that contains human waste.

Sharps. Discarded hypodermic needles and blades used fro medical practice. They can be contaminated with drugs and human tissue.

Small Quantity Generator (SQG). Businesses which generate small quantities of hazardous wastes each year.

Smoke. Particles suspended in air after incomplete combustion of materials containing carbon.

Solidification. The containing of hazardous wastes into a solid matrix.

Subarctic. Regions adjacent to the arctic in which one to three calendar months have a mean monthly temperature above 10 C and at least one month has a mean monthly temperature of 0 C or colder.

Tailings. Residue of raw materials or waste separated out during the processing of mineral ores.

Tailings pond. A lagoon used to treat and dispose of selected wastes generated by the mining industry.

Toxic. Used to describe a substance that may present unreasonable risk of injury to health or the environment.

Toxicity. The degree of danger posed by a toxic substance to human animal or plant life.

Trucked water system. A truck or tractor system which transports water or ice from a source to individual buildings, and/or collects wastewater and transports it to a treatment or disposal point.

Tundra. Term applied to the treeless areas in the arctic and subarctic; consists of mosses, lichens, and small brush.

Utilidor. An above or below ground conduit that acts as an enclosed corridor for a network of pipes and cables which supply community services to individual homes and businesses.

Vaporization. The change of a substance from a liquid to a gas.

Volatile. Any substance that evaporates at a low temperature.

Waste. Unwanted materials left over from human activities.

Waste oil. Oil which is discarded because its original properties have been altered.

Water pollution. The addition of enough harmful or objectionable material to damage water quality.

APPENDIX B

GLOSSARY OF HAZARDOUS SUBSTANCES INCLUDING THEIR HARMFUL EFFECTS

Taken from: Scanlon, 1987 and Stecher, 1968

Ammonia. A substance used for copying of blueprints. Inhalation of the concentrated vapour causes swelling of the respiratory tract which can result in suffocation.

Arsenic. A heavy metal which is highly toxic in most forms. Swallowing can result in nausea, vomiting, and diarrhoea which can progress to shock and death. Prolonged exposure to small concentrations can result in liver and kidney damage.

Asbestos. A mineral fibre used as an insulating material. It can cause cancer or asbestosis if inhaled or swallowed.

Barium. A substance which can be present in waste oil. All water-soluble or acid-soluble barium compounds are poisonous.

Benzene. A solvent which may be a contaminant in waste oil. Exposure by swallowing or inhalation can cause irritation of mucous membranes, restlessness, convulsions, excitement, or depression. Death may follow from respiratory failure. Chronic exposure through skin contact may cause leukaemia.

Benzo(a)pyrene. A contaminant sometimes present in waste oil. It is a potential carcinogenic agent.

Beryllium. A metal that can be hazardous to human health when inhaled. Death may result from relatively low exposures to extremely low concentrations of the element and its salts. It is discharged by machine shops, ceramic and propellant plants, and foundries.

Cadmium. A heavy metal element that can accumulate in the environment. Ingestion can result in increased salivation, choking, vomiting, abdominal pain and diarrhoea. Inhalation can result in throat dryness, coughing, headaches, vomiting, chest pains, and extreme restlessness and irritability.

Caustic soda. Sodium hydroxide ($NaOH$), is a strong alkaline substance used as the cleaning agent in some detergents. It is corrosive to all tissues. Ingestion may cause vomiting, and collapse. Inhalation of the dust or mist may cause damage to the respiratory tract.

Chloroform. A solvent which is believed to cause cancer.

Chromium. Chromium is a heavy metal which can cause skin irritation when contacted. Inhalation can cause nasal irritation. Violent intestinal irritation with vomiting and diarrhoea result from swallowing the substance.

Contact pesticide. A chemical that kills pests when it touches them, rather than by being eaten (stomach poison).
Creosote. A substance commonly used as a wood preservative. Large doses may cause intestinal irritation, cardiovascular collapse and death.
Dichlorodifluoromethane. A contaminant which may be present in waste oil. It has little toxic action but can form toxic substances when burned.
DDT. The first chlorinated hydrocarbon insecticide (chemical name: 1,1,1-trichlorous-2,2-bis (p-chlorophenyl)-ethane.) It has a half-life of 15 years and can collect in fatty tissues of certain animals. Poisoning results from swallowing, skin contact or inhalation. Death occurs within 24 hrs of receiving a fatal dose of 500 mg/kg body weight. Solvents such as kerosene increase its toxicity.
Ethylene Glycol. This substance is used as antifreeze. When swallowed it can cause depression, vomiting drowsiness, fatigue, respiratory failure, and convulsions, which may proceed to death.
Fluorocarbons. A gas used as a propellant in aerosols. They are believed to be modifying the ozone layer in the stratosphere thereby allowing more harmful solar radiation to reach the Earth's surface.
Heavy metals. Metallic elements such as mercury, chromium, cadmium, arsenic, and lead, with high molecular weights. They can damage living things at low concentrations and tend to accumulate in the food chain.
High density polyethylene. A material used to make plastic bottles that produces toxic fumes when burned.
Hydrocarbons. Compounds found in fossil fuels, that contain carbon and hydrogen and may be carcinogenic.
Hydrogen Sulphide (H_2S). The gas emitted during organic decomposition that smells like rotten eggs. It is also a by-product of oil refining and burning. It is extremely hazardous and can cause collapse, fatigue or death from respiratory failure within a few seconds after inhalation. Headaches, dizziness and nausea may appear after exposure to low concentrations.
Kerosene. A fuel used in lamps and stoves. Inhalation of high concentrations can cause headaches, drowsiness, and coma. Swallowing causes vomiting and diarrhoea.
Lead. Lead is a heavy metal which is a major contaminant in waste oil. It is also present in some paints. Acute exposure may result in permanent brain damage. Chronic lead poisoning can result in weight loss, weakness and anaemia.
Methyl Alcohol. Ingestion of this substance can result in poisoning, headaches fatigue nausea or complete blindness.

Mercury. Mercury can be present in some paints. It is a heavy metal, which can accumulate in the environment. Acute exposure to soluble mercury salts can cause violent corrosive effects on skin and mucous membranes, severe nausea, vomiting, abdominal pain, bloody diarrhoea, kidney damage and death usually within 10 days.

Methylene Chloride. Used as a paint thinner. It can be a narcotic in high concentrations.

Mineral Spirits. Also called petroleum spirits. Inhalation of high concentrations can cause headaches, drowsiness, and fatigue. Swallowing causes vomiting and diarrhoea.

Naphtha (Petroleum Benzina). Naphtha is a commonly used solvent. Inhalation of high concentrations can cause headaches, drowsiness, and coma. Swallowing causes vomiting and diarrhoea.

Naphthalene. Naphthalene is used in moth balls. It is also a contaminant in waste oil. Poisoning can occur from swallowing large doses, inhalation or skin adsorption. Symptoms are nausea, vomiting, headaches, fever, convulsions and fatigue.

Nitric oxide (NO). A gas formed by combustion under high temperature and high pressure in a gas or diesel engine. It changes into nitrogen dioxide in the ambient air.

Nitrogen dioxide (NO_2). It is one of the most insidious gases. Exposure can cause inflammation of the lungs. This will only cause slight pain but the resulting tumour several days later may result in death. 100 ppm is dangerous for even short exposures and 200 ppm may be fatal.

Ozone (O_3). A pungent, colourless, toxic gas. High concentrations cause severe irritation of the respiratory tract and eyes.

PCB's (Polychlorinated biphenyls). A group of toxic, persistent chemicals used in transformers and capacitors. Extensive exposure can cause chloracne, a painful and disfiguring skin condition, similar to adolescent acne. Liver damage can also result. Brief exposures may cause skin rashes, swelling eyelids, headaches or vomiting. Long exposure to PCB's in animals can severely affect reproduction, and cause cancer.
(Canadian Council of Resource and Environment Ministers, 1986)

Pentachlorophenol (penta, PCP).
This is commonly used as a wood preservative. It causes lung, liver, and kidney damage. More toxic in organic solvents.

PERC (Perchloroethylene). A commonly used dry-cleaning substance. It is harmful to the liver and kidneys in humans if swallowed. It may also be carcinogenic.

Persistent pesticides. Pesticides that do not break down chemically and remain in the environment after a growing season.

Phenols. Organic compounds that are by-products of petroleum refining, tanning, textile, dye and resin manufacture. Low concentrations can cause taste and odour problems in water, higher concentration can kill aquatic life.
Phosphates. Chemical compounds containing phosphorous. High concentrations in water bodies can stimulate the growth of algae causing depletion of oxygen in the water.
Polyvinyl chloride. A commonly used plastic that releases hydrochloric acid when burned.
Propane. A compound that may be present in discarded gas cylinders. It can be a narcotic at high concentrations.
Sulphur dioxide (SO_2). A heavy, pungent, colourless gas formed primarily by the combustion of fossil fuels. It may be intensely irritating to the eyes and respiratory tract.
Sulphuric acid. The most commonly used acid in batteries. It is corrosive to all body tissues. Inhalation of concentrated vapour can cause serious lung damage. Contact with eyes may result in total loss of vision. Swallowing may cause severe injury and death.
Tetrachloroethylene. A solvent which may be present in waste oil. Considered to be the most toxic of the common chlorinated hydrocarbons. Poisoning can occur by inhalation, ingestion or skin contact. Symptoms are nausea, vomiting, diarrhoea, headaches and liver and kidney damage.
Toluene. This is a solvent which can be present in waste oil. It may cause anaemia. It is a narcotic at high concentrations.
1,1,1-Trichloroethane. A solvent which may be present in waste oil. It is irritating to the eyes and mucous membranes and a narcotic at high concentrations.
Trichloroethylene. This is a solvent which is sometimes used in dry-cleaning, and may be a contaminant in waste oil. It is a narcotic at high concentrations. Deaths have occurred after heavy exposures.
Turpentine. A commonly used solvent which is irritating to the skin and mucous membranes. It can also cause severe kidney irritation.
Vinyl chloride. A chemical compound used in producing some plastics. It may be a narcotic at high concentrations. It is also believed to be carcinogenic.
Xylene. A solvent which may be a contaminant in used oil. It may be a narcotic in high concentrations.
Zinc. A contaminant which may be present in waste oil. Inhalation can cause throat dryness, coughing, weakness, generalized aching, chills, fever, nausea, and vomiting. Ingestion may cause nausea, and vomiting.

APPENDIX C

THE NWT HAZARDOUS WASTE QUESTIONNAIRE, '90

The following is a copy of the questionnaire distributed in conjunction with this study. Each business/industry received the cover page and Parts A, B and one of the sections in Part C.

Municipalities were given the entire survey.

NORTHWEST TERRITORIES HAZARDOUS WASTE SURVEY

COMPANY NAME/COMMUNITY NAME: ______________________________

QUESTIONNAIRE COMPLETED BY: ________________ ________________

NAME **TELEPHONE NO.**

________________ ________________

POSITION **ADDRESS**

<u>INSTRUCTIONS</u>:

1. Read the definition of Hazardous Wastes given in Part A.

2. Complete Parts B and C. If records are not available knowledgeable estimated values are all that is required.

3. Return the questionnaire in the enclosed envelope by Friday, August 31, 1990 to Mr. Ron Kent, P.Eng., Municipal and Community Affairs, Yellowknife, N.W.T.

4. If your business/industry does not generate any hazardous wastes, please indicate this on the questionnaire and return it to us.

If you have any comments or questions, please call P.L. Heeney at (403)920-6112.

Thank you for your cooperation.

PART A

DEFINITION OF HAZARDOUS WASTE

In the transportation of Dangerous Goods Regulations "Hazardous Waste means a product, substance or organism that is, dangerous goods no longer used for its original purpose..."

Practially hazardous wastes can be characterized into seven catagories:

1. Flammable - Liquids or solids that can ignite (e.g. waste fuel, turpentine, paint thinner, etc.)

2. Corrosive - Substances that eat and wear away at many materials (e.g. car battery acid, caustics, drain-cleaners, etc.)

3. Reactive - Materials that can create an explosion or produce harmful vapours (e.g. explosives, ammunition, etc.)

4. Poisonous - Substances that are poisonous or lethal (e.g. waste oil, mercury, cyanide, arsenic, pesticides, antifreeze, etc.)

5. Infectious - Materials that can cause disease (e.g. medical wastes, honey bag wastes, sewage sludge, animal carcasses, etc.)

6. Environmental Contaminants - Materials which bioaccumulate and persist in nature (e.g. DDT, PCB's etc.) PCB's are not included in this study.

7. Radioactive - Substances which emit ionizing radiation or objects contaminated with particles of substances which emit ionizing radiation (e.g. uranium, ionization type smoke alarms, etc.)

N.B.: Under the transportation of dangerous goods act, the category "Toxic" is used for both poisonous and infectious wastes.

PART B GENERAL HAZARDOUS WASTES

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Municipal Landfill	Onsite Landfill	Dust Suppression	Burned for Heat	Open Burning	Incineration	Sewer	Stored On Site	Sent out of NWT	Other (specify)
												Disposal Method
Waste Oil - waste lube oil/ hydraulic fluid												
- oil/water mixtures												
- oil filters												
Spent solvents (degreasers, rust remover, turpentine, cleaners, etc.)												
Waste Paint (not latex)												
Waste Paint Thinner												
Soil Contaminated with - chemicals												
- petroleum products												
- waste oil												
Contaminated Containers (oil drums etc.)												
Sewage Sludge												

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ______________________

____

____

Comments: ______________________

____

____

PART C

Part C is divided into 12 sections, each specific to a different service type. The sections are:

- C-1 Municipal Landfill Sites
- C-2 Transportation/Moving & Cartage/Vehicle & Equipment Rental/Vehicle & Equipment Maintenance/Fuel Supply
- C-3 Construction/Lumber/Welding & Fabrication/Painting/Glass, Wood and Concrete Products
- C-4 Manufacturing
- C-5 Electricity, Gas, and Communication Facilities
- C-6 Printing/Publishing/Photo Finishing
- C-7 Educational Facilities
- C-8 Retail Outlets
- C-9 Medical, Dental & Veterinary Clinics/Funeral Homes
- C-10 Dry Cleaners
- C-11 Metal Mining/Oil & Gas Exploration
- C-12 Other

Complete only the sections which apply in your community.

PART C

C-1 Wastes which are present at Municipal Landfill Sites

Waste Type	Amount (#)
Waste Oil or Fuel Drums (full or partially full)	
Empty Oil or Fuel Drums	
Acid Batteries	
Industrial Chemicals	
Animal Carcasses	
Contaminated Soils	
Contaminated Liquids (e.g. spilled products)	
Other (Please Specify) ________________	

Where is pumpout sewage disposed?

- With garbage at landfill ☐
- Sewage Lagoon ☐
- Disposal Pit ☐
- Other (specify) ☐ ____________

# of houses using pumpout sewage ________

# of houses using bagged sewage ________

PART C

C-2 Transporation/Moving and Cartage/Vehicle & Equipment Rental/ Vehicle & Equipment Maintenance/Fuel Supply

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Disposal Method: Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)				
Contaminated Fuels													
Fuel Tank Sludges													
Acid Batteries													
Anti-freeze													
Windshield Washer Fluid													
Resins (Epoxy, Catalyst, Fiberglass resin, etc.)													
Adhesives													
Flammable Waste													
Other (please specify)													

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ______________________

Comments: ______________________

PART C

C-3 Construction/Lumber/Welding & Fabrication
Painting/Glass, Wood & Concrete Products

Disposal Method

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)			
Primers & Sealers												
Paint Sludge												
Strippers												
Lacquers												
Resins (Epoxy, Catalyst,												
Fiberglass Resin, Urethane ETC)												
Adhesive (Acrylic glues,												
Contact cement, Tile cement,												
paneling adhesive)												
Waste Tar and Residues												
Asbestos												
Metal Dust												
Cutting Oil												
Flammable Waste												

CONTINUED NEXT PAGE

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ______________________________

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Comments: ______________________________

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C-3 Continued....

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Disposal Method: Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)				
Wood Preservative (arsenic,													
Copper Naphthenate,													
Creosote, Penta, etc.)													
Curing Agents													
Gas Cylinders													
Contaminated Containers													
Acid Batteries													
Other (please specify)													

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ______________________________

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Comments: ______________________________

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PART C

C-4 Manufacturing

Disposal Method

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)				
Metal Dust & Machining Waste													
Cutting Oil													
Resins (Epoxy, Fiberglass													
Resin, Urethane, etc.)													
Adhesives													
Flammable Wastes													
Metal Finishing Solutions													
Acids (specify) ______													
Alkalis (specify) ______													
Aqueous Solutions (specify)													
Process Chemicals/Reagents													
Contaminated Containers													
Other (Specify)													

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ______________________________

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Comments: ______________________________

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PART C

C-5 Electricity, Gas & Communication Facilities

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Disposal Method: Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)				
Asbestos													
Mercury													
Empty Gas Cylinders													
Contaminated Fuels													
Tank Bottoms													
Acid Batteries													
Flammable Waste													
Maintenance Chemicals													
Acids (specify)													
Alkalis (specify)													
Other (specify)													

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ______________________

Comments: ______________________

PART C

C-6 Printing, Publishing and Photo Finishing

Disposal Method

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)				
Fixers													
Developers													
Ammonia for Blue Print Machines													
Waste Ink													
Ink Sludge													
Contaminated Containers													
Other (specify)													

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ______________________________

Comments: ______________________________

PART C

C-7 Education..l Facilities

			Disposal Method									
WASTE TYPE	Amount Generated Per Year	Amount in Storage	Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)			
Solid Waste Chemicals												
(specify) ______												
Liquid Wastes												
Formaldehyde												
Acids (specify)												
Alkalis (specify)												
Contaminated Containers												
Other (specify)												

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ______________________________

Comments: ______________________________

* NOTE: If you require more space, please attach additional paper.

PART C

C-8 Retail Outlets

You are asked to identify hazardous substances sold at your establishment, not those generated by your activities.

Please estimate:

Product	Quantity Sold/Year
Acid Batteries	
Engine Oil	
Small Batteries	
Household Cleaners	
Glues	
Paint	
Solvents	
Insecticides/Pesticides	
Anti-freeze	
Disposable Diapers	
Other (specify) ______________ ______________	

Do you expect any of these to change in the near future? Yes

No

If yes please explain: ______________

Comments: ______________

PART C

C-9 Medical, Dental & Veterinary Clinics
Funeral Homes

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Disposal Method: Municipal Landfill	Burned at Landfill	Sewer	Stored on Site	Sent out of NWT	Recycle	Burning Barrel in Town	Other (specify)		
Surgical Dressings												
Disposables used in Medical Practice												
Anatomical Wastes												
Sharps												
Out of Date Medication												
Discarded Thermometers												
X-Ray Developing Fluid												
Waste Formaldehyde												
Disinfectants												
Animal Carcasses												
Other (specify)												

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ____________________

Comments: ____________________

PART C

C-10 Dry Cleaners

Which dry cleaning substance is used at your establishment?

☐ Perchloroethylene (PERC)

☐ Petroleum Solvent (Stoddard Solvent)

☐ Valciene (Fluorocarbon 13)

☐ Other (Please Specify) ______________________

Disposal Method

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)				
Still residues from solvent distillation													
Spent Filter Cartridges													
Cooked Powder Residue													
Other (specify)													

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain ______________________

Comments ______________________

PART C

C-11 Metal Mining
Oil and Gas Exploration

Disposal Method

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)	Tailings Pond	Onsite Landfill	
Tank Sludges (reagent and fuel tanks)												
Drilling Mud												
Explosives												
Mill & Process Reagents												
(please specify)												
Lab Reagents (specify)												
Maintenance Chemicals												
Acid Batteries												
Contaminated Fuels												
Glycol (anti-freeze, liquid												
dessicant, etc.)												
Resins (Epoxy, catalyst,												
fiberglass resin, etc.)												
Adhesives												

CONTINUED ON NEXT PAGE

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ______

Comments: ______

C-11 Continued...

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)	Tailings Pond	On site Landfill	
Strippers												
Lacquers												
Cutting Oil												
Contaminated Containers												
Contaminated Filters												
Other (specifv)												

Disposal Method

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ____________________

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Comments: ____________________

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PART C

C-12 Other

Disposal Method

WASTE TYPE	Amount Generated Per Year	Amount in Storage	Municipal Landfill	Open Burning	Sewer	Stored on Site	Sent out of NWT	Recycle	Other (specify)			
Explosives												
Ammunition												
Maintenance Chemicals												
Biological Wastes												
(animal carcasses)												
Other (specify)												

Do you expect any of these quantities to change in the future? Yes ☐ No ☐

If yes please explain: ____________________

Comments: ____________________

APPENDIX D

ADDITIONAL SURVEY RESULTS

1) Estimated Hazardous Waste Generation Quantities for the Tax-Based Communities

The following are the quantities of hazardous wastes estimated for each of the tax-based communities. These values were calculated using questionnaire results to estimate the values for businesses which did not complete the survey.

TABLE D-1
QUANTITIES OF HAZARDOUS WASTES GENERATED
IN FORT SIMPSON, FORT SMITH, AND HAY RIVER

Waste Classification	Fort Simpson	Fort Smith	Hay River
Organic Sludges and Still Bottoms	100 L	100 L	500 L
Solvents and Organic Solutions	400 L	2,000 L	4,700 L
Oils and Greases	36,100 L	90,800 L	146,700 L
Oil/Water Mixtures	100 L	100 L	5,300 L
Organic and Oily Residues	400 L	500 L	11,600 L
Miscellaneous Chemicals	100 kg	800 kg	3,600 kg
Paint and Organic Residuals	500 L	900 L	1,700 L
Aqueous Solutions with Organics	2,600 L	2,500 L	2,800 L
Clean-up Residuals	300 t	200 t	2,400 t
Household Hazardous Wastes	2,500 kg	6,200 kg	7,100 kg
Bulky Wastes-oil filters	1,000	2,900	3,700
-containers	100	100	600
-gas cylinders	50	50	50
-filters	---	---	10

TABLE D-2
QUANTITIES OF HAZARDOUS WASTES GENERATED
IN INUVIK AND IQALUIT

Waste Classification	Inuvik	Iqaluit
Organic Sludges and Still Bottoms	900 L	1,300 L
Solvents and Organic Solutions	2,200 L	1,600 L
Oils and Greases	55,100 L	41,200 L
Oil/Water Mixtures	1,600 L	500 L
Organic and Oily Residues	2,000 L	2,600 L
Miscellaneous Chemicals	3,700 kg	1,900 kg
Paint and Organic Residuals	4,800 L	1,000 L
Aqueous Solutions with Organics	2,000 L	1,600 L
Clean-up Residuals	2,100 t	4,500 t
Household Hazardous Wastes	6,700 kg	7,600 kg
Bulky Wastes-oil filters	1,900	2,500
-containers	100	200
-gas cylinders	50	400
-filters	50	70

TABLE D-3
QUANTITIES OF HAZARDOUS WASTES GENERATED
IN NORMAN WELLS AND YELLOWKNIFE

Waste Classification	Norman Wells	Yellowknife
Organic Sludges and Still Bottoms	200 L	2,300 L
Solvents and Organic Solutions	2,200 L	10,600 L
Oils and Greases	57,100 L	693,900 L
Oil/Water Mixtures	1,000 L	4,100 L
Organic and Oily Residues	1,100 L	16,300 L
Miscellaneous Chemicals	200 kg	18,000 kg
Paint and Organic Residuals	1,000 L	6,000 L
Aqueous Solutions with Organics	1,800 L	7,500 L
Clean-up Residuals	2,300 t	12,100 t
Household Hazardous Wastes	1,500 kg	30,100 kg
Bulky Wastes-oil filters	2,400	6,100
-containers	300	900
-gas cylinders	100	300
-filters	---	100

2) Quantities of Hazardous Wastes Report at Landfill Sites

The following are quantities of hazardous substances which several communities identified at their landfill sites.

TABLE D-4
QUANTITIES OF HAZARDOUS WASTES REPORTED
AT MUNICIPAL LANDFILL SITES

Community	Full Drums (#)	Empty Drums (#)	Bat-teries (#)	Car-casses (#)	Cont. Soil (m^3)	Rotted Meats (m^3)
Broughton Island	0	0	1	0	0	0
Fort McPherson	4	6	0	150	0	0
Hall Beach	10	400	5	30	0	0
Hay River	10	30	100	100	0	10
Igloolik	0	0	2	0	0	0
Inuvik	0	500	500	100	50	0
Iqaluit	50	1,000,000	1,000	0	200	0
Paulatuk	0	23	0	0	0	0
Repulse Bay	8	30	10	5	0	0
Resolution Bay	0	0	0	3	0	0
Sachs Harbour	0	25	0	30	0	0
Sanikiluaq	6	6	31	2	0	0

3) Disposal Methods Employed in the NWT

These methods are listed in order of number of respondents employing them. The most frequently used is listed first.

Table D-5: Disposal Methods Used for Organic Sludges and Still Bottoms (no oil)

Waste	Disposal Methods
Resins	landfill/dump open burning stored
Lacquers	landfill/dump incineration
Dry-Cleaning Residues	sent out stored on-site sent out

Solvents and Organic Solutions
(discussed in chapter 13)

Oils and Greases
(discussed in chapter 13)

Table D-6: Disposal Methods Used for Oil/Water Mixtures

Waste	Disposal Methods
Oil/Water Mixtures	open burning stored on site landfill heating sent out landfarm dust suppression

Table D-7: Disposal Methods Used for Organic and Oily Residues

Waste	Disposal Methods
Tank Sludges	open burning landfill stored incinerated tailings pond sent out landfarmed recycle

Table D-8: Disposal Methods Used for Miscellaneous Chemicals

Waste	Disposal Methods
Ammonia	sewer
Waste Ink	landfill
Ink Sludge	landfill sewer
Fixers	sewer sent-out
Developers	sewer
Lab and Process Reagents	tailings pond sewer pipeline sent south
Wood Preservatives	landfill
Curing Agents	open burning
Flammable Wastes	open burning landfill sewer
Explosives	to explosives experts burned

Table D-9: Disposal Methods Used for Paint and Organic Residuals

Waste	Disposal Methods
Waste Paint	see chapter 13
Paint Sludges	stored on site
Adhesives	landfill open burning stored incineration
Tar	landfilled open burning stored incineration

Table D-10: Disposal Methods Used for Aqueous Solutions with Organics (90% Water)

Waste	Disposal Methods
Anti-freeze	landfill stored open burning sewer recycle discharged to ocean dust control fire practice evaporation incineration injection stored
Windshield Washer	landfill sewer

Table D-11: Disposal Methods Used for Clean-up Residuals

Waste	Disposal Methods
Contaminated Soil	stored open burning heating fire training landfill landfarm
Drilling Mud	on-site landfill discharged to ocean

Table D-12: Disposal Methods Used for Bulky Wastes

Waste	Disposal Methods
Gas Cylinders	see chapter 13
Oil Filters	see chapter 13
Contaminated Containers	landfilled stored sent south burned recycled
Contaminated Filters	landfill stored on-site open burning
Asbestos	stored buried

APPENDIX E

HOUSEHOLD HAZARDOUS WASTE MINIMIZATION

Taken from: Environment Canada, 1988, and
Giannelli Pratt, 1990

The following tables contain helpful suggestions for minimizing household hazardous wastes. Some of them may require more muscel powere than toxic chemicals but they will help to reduce the quantity of hazardous wastes produced in household. These waste minimization suggestions demonstrate that public education about hazardous waste minimization can help reduce the household hazardous waste stream volume. The following three tables offer alternatives to:

- aerosol sprays;
- products containing caustic chemicals; and
- products containing solvents.

Aerosol Sprays

Aerosol products can contain up to 50% liquid or gaseous propellant under pressure. Some of these propellants are organic solvents that dissolve or suspend substances and can persist in the environment.

TABLE E-1
ENVIRONMENTALLY FRIENDLY ALTERNATIVES
TO AEROSOL SPRAYS

Examples	Comments	Alternatives
Deodorants	Mist particles from the aerosol can be small enough to be inhaled.	Roll-ons, creams, sticks, non-aerosol sprays.
Hair Spray		Setting lotion, gels or pump sprays.
Shaving Cream		Soap and brushes
Glass & Window Cleaners		Use pump spray cleaners. Make your own by adding 15 mL vinegar to 1 L of water, or use undiluted lemon juice.
Air Fresheners		Ventilate. Use an open box of baking soda or a dish filled with vinegar.
Camera Cleaners		Use liquid or pump sprays.

Products Containing Caustic Chemicals

These products are highly corrosive (causing burns) and forthis reason are effective cleaners. They also can cause severe skin and eye damage.

TABLE E-2
ENVIRONMENTALLY FRIENDLY ALTERNATIVES
TO CAUSTIC CHEMICALS

Examples	**Comments**	**Alternatives**
Oven Cleaners	Oven cleaners may contain sodium hydroxide or potassium hydroxide, which are extremely corrosive. Mist and vapours can also irritate the respiratory tract and lungs.	Use heat activated, non-toxic, non-corrosive oven cleaners. Line bottom of oven with foil.
Toilet Bowl Cleaners and Rust Removers	Toilet bowl and drain cleaners can cause severe burns if accidentally spilled on skin.	Use 125 mL of bleach, mild detergent or baking soda. Clean toilets often and you won't need strong chemicals.
Drain Cleaners		Prevent clogging by using a drain strainer. Use a plunger or metal snake. Flush drain weekly with boiling water as a preventative measure.
Laundry Detergent		Use a low phosphate, biodegradable product, pure soap or washing soda.
Chlorine Bleach	Never mix chlorine bleach with ammonia or acids- a deadly gas forms.	Use non-chlorine bleaches or other laundry additives.
Ammonia-based Bleaches/Cleaners	Use powdered, not liquid cleaners.	125 mL ammonia plus 125 mL washing soda mixed with 2 L warm water is a good general household cleaner.
Abrasive Porcelain Cleaners	Use powdered, not liquid cleaners.	Buy products containing only silica and soap or containing calcium carbonate. Baking soda is a good alternative.

Products Containing Solvents

Solvents are fast-drying substances used to dissolve another compound. Breathing of these vapours or accidental swallowing can be harmful or even fatal. Some are also flammable.

TABLE E-3
ENVIRONMENTALLY FRIENDLY ALTERNATIVES
TO SOLVENTS

Examples	**Comments**	**Alternatives**
Furniture Polish (solvent based)	These products can contain chemicals which may be potent cancer causing agents or otherwise harmful to the environment.	To make a polish, melt 15 mL carnauba wax into 500 mL mineral oil.
Aluminum Cleaner		To clean stained aluminum, mix 30 mL non-abrasive laundry detergent in 1 L water, and scrub with a stiff brush.
Copper Cleaner		Pour vinegar and salt over copper and rub.
Paint Removers and Thinners	These products can contain substances harmful to the environment or humans. Methylene chloride is used extensively in paint removers.	Use water soluble cleanup products if available.
Paints (oil based)		Use latex or water-based paint if possible.
Rug and Upholstery Cleaners		Clean stains immediately with club soda or use soap-based, non-aerosol rug shampoo.
Spot removers/Dry Cleaning Fluids	Some older products may contain benzene or tetrachloroethylene.	Don't use unless absolutely necessary and then ventilate well. Try club soda followed by cold water.
Wood Preservatives	Both oil based and water based preservatives are highly toxic to the environment. They can also bioaccumulate and contain carcinogenic agents. Avoid skin contact and use in well ventilated areas.	Avoid using if possible by buying commercially treated wood and only apply preservatives to spot treat end cuts. Avoid using products containing pentachlorophenol or creosote.

END

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