

PN-ABM-910

80205

**Conservation for Development
in
Botswana, Kenya, Somalia, Sudan**



**Urban Industrial Solid Waste Pollution in Botswana:
Practices, Attitudes, and Policy Recommendations**

Eagilwe M. Segosebe with C. Vander Post

African-Caribbean Institute

Eagilwe M. Segosebe holds a B.A. degree in Geography and African Languages from the University of Botswana and Swaziland, and an M.A. in International Development from Clark University. He currently serves as a lecturer in the Department of Environmental Science at the University of Botswana. Mr. Segosebe's ACI research centers on the dilemmas of commercial and industrial waste management in the major urban and mining areas of Botswana. Toxic waste disposal is becoming an ever more serious problem and is directly related to Botswana's developmental successes. Since independence, the country has enjoyed one of Africa's highest economic growth rates. This prosperity has led to increasing urbanization, investment in small and large industries, and, inevitably, industrial waste contamination. The Segosebe paper examines the major dimensions of this threat to Botswana's delicate and easily disrupted environment, and recommends policy reforms to square waste-management practices with the environmental and ecological requirements of sustainable economic development.

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**African-Caribbean Institute
African Natural Resources Fellowship Program
Working Paper Series**

**CONSERVATION FOR DEVELOPMENT IN
BOTSWANA, KENYA, SOMALIA, AND SUDAN**

**Edited by
Rodger Yeager**

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RFID

**African-Caribbean Institute
1991**

FOREWARD

This publication is a part of a larger body of materials from eight authors in eastern and southern Africa that have been sponsored by the African-Caribbean Institute's Natural Resource Project. The combined works are in three main sectors. Papers by Betty Wamalwa and Mutasim El Moula focus on traditional institutions in environmental management in Kenya and Sudan. Papers by Mohamud Jama, Ahmed Yasin, Ahmed Hassan, and Amina Warsame are concerned with specific sector issues in energy, dry land fishing, camel husbandry, and women in forestry in Kenya and Somalia. The final section by Eagilwe Segosebe and Alawiyya Ahmed concerns modern industrial waste management problems in Botswana and finally the important issues of environmental education in Sudan.

Further studies will focus on issues of forestry and women and the preservation of biological diversity in eastern and southern Africa. As with the projects that are nearing completion or currently underway, the African-Caribbean Institute will edit, publish, and disseminate the works. This commitment and all other aspects of the African Fellowship Program are intended to serve ACI's ultimate goal of assisting in the quest for genuinely African solutions to African problems of resource conservation and development.

In addition to those who participated in the project, the African-Caribbean Institute wishes to thank Dr. Richard Ford of Clark University who served as Senior Natural Resources Advisor and the national advisers in each country. We are also grateful to John Gaudet and John Koehring at USAID and to Diane Rocheleau and Eric Rusten of the Ford Foundation for advice and support.

At Dartmouth College the Environmental Studies Program under the direction of Dr. James Hornig has provided project support. Betty Ann Miller is acknowledged for her excellent production management as is Bonnie Stone for her professional assistance in publishing the text.

Norman N. Miller, President
African-Caribbean Institute

Published by the
African-Caribbean Institute
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ACKNOWLEDGEMENTS

We wish to thank the African-Caribbean Institute for providing all the financial support required to carry out and produce this study. The funds were administered by the Kalahari Conservation Society. Our thanks go to them too.

We are indebted to our interviewers whose hard work enabled us to complete the field work on time. Particular thanks go to our research assistant Kavita Datta who did most of the field supervision.

Our special gratitude goes to our respondents. First and foremost, we thank the company managers whose timely responses made this study a success. We particularly thank them for their openness with their information. Secondly, we wish to thank the various government officials for the useful and indeed informative discussions we have had with them. Special thanks go to Mr. E. Thekiso of the Department of Labour and Social Security, Mr. Magidizela of the Department of Water Affairs, and Mr. Mbayi of the Ministry of Commerce and Industry.

Special mention needs to be made of the sanitation authorities of both the Lobatse Town Council and Gaborone City Council, for unreservedly supplying us with the information we needed. Finally, two people deserve mention, Mr. Koorutwe for drawing the only map of this study, and Ms. Popo who did the typing of this document.

Special thanks also go to staff members of the Department of Environmental Science whose comments helped shape this report.

URBAN INDUSTRIAL WASTE AND POLLUTION IN BOTSWANA

INTRODUCTION

Until very recently the problem of hazardous wastes and their safe disposal did not receive much attention in Botswana. This is a common phenomenon in all developing countries in their pre-industrial stage or on the verge of industrialization. The same was true about present industrial countries in the early years of their industrialization. Such was and continues to be a result of human attitudes toward economic, increased resource utilization, and consumption. The desire for an improved standard of living derived from resource utilization, and the ability of the latter to provide it overwhelmed any thought of the secondary effects that could arise from industrial processes and resulting wastes. In Botswana, this state of affairs is manifest in the fact that most by-laws relating to waste management and disposal are either confined to household refuse or encompass an amalgam of waste types without appropriate distinction among them.

As a result, current local government by-laws are completely silent on the question of handling commercial or industrial solid wastes, including those which may be hazardous. Even though some general guidelines have been developed on the levels of pollutants allowed by local authorities in public sewage systems, no similar guidelines exist for the disposal of industrial solid wastes. Generally industrial solid wastes have been treated as if they were all inert or easily bio-degradable. The Gaborone City Council, for instance, employs the term "refuse" to cover all solid wastes irrespective of their origin (i.e. whether household, commercial, or industrial).

Changes that have characterized Botswana's economy since independence call for reciprocal changes in both attitudes toward and methods of handling industrial wastes from various sectors of the economy. Botswana has experienced one of the highest economic growth rates since independence. The National Development Plan 1985-91 (NDP 6) estimated the average gross domestic product (GDP)

growth rate at 12.4 percent annually between 1977/78 and 1982/83. This means that substantial resources were utilized to achieve such rapid economic growth. As in many developing and developed countries, industrial development is seen as an important engine of economic growth and prosperity. Therefore, industrial development has been highly encouraged as an essential component of general development efforts in Botswana during the post-independence period. To facilitate industrial development, the government of Botswana has adopted an open and liberal investment policy with offers incentives to investors ranging from initial tax waivers in some places to limited restrictions on repatriation of returns. On the other hand, worldwide experience from industrial countries shows that rapid industrial growth has its adverse side effects. Expansion of the industrial sector raises, among other things, concern about wastes and pollution that often accompanies industrial activities. This is because industries generate a large quantity and diversity of hazardous wastes which may ultimately cause environmental and health problems (United Nations Environment Programme [UNEP], 1988).

In order to avoid creating problems of environmental and natural resource destruction and health problems for future generations, there is need for the present generation to devise a comprehensive but practical policy toward the management of industrial wastes. This is no doubt considered in the National Conservation Strategy currently being developed by the Botswana Government. The purpose of this paper is to review the current practice of industrial waste disposal in Botswana's urban areas. It particularly examines the needs and attitudes of industrial operators relating to industrial solid wastes. Also investigated are the waste disposal regulations and practices of municipal authorities in selected urban centres.

THE STATE OF THE ART

The Global Situation. Pollution from industrial wastes dates back to the industrial revolution in Europe. Unfortunately, in the past as is now the case in many countries of the world, the disposal of wastes was thought to be safe. Wastes were not only dumped on nearby land but also in oceans as well as in lakes and streams. Wastes, it was believed, would degrade into harmless products or at least remain in the same place. This assumption has since been proven wrong. Many wastes do not degrade, degrade very slowly, or degrade into substances that are also hazardous. Wastes deposited on the land surface or under landfills do not remain in the same place for long periods as was originally thought. In contrast, wastes may seep into the ground or be moved by wind, storm water, and floods into other locations. Such wastes create substantial human risks long after their disposal.

Improper disposal of wastes is not only a problem for the developing world but remains a big problem for the developed world. Experience from the industrial countries of Europe and North America indicates that concern for economic advancement was neither simultaneously nor equally matched by concern for proper waste management. This was particularly true during their early years of industrialization, and it is still evident in the current transboundary shipment of hazardous wastes, particularly from the industrial countries to poor countries (Bulska, 1989; the World Commission on Environment and Development WCED, 1987). The current drive toward proper disposal of wastes in the industrial world is best seen as reactive rather than proactive, especially in that it has resulted from serious environmental pollution. Environmental pollution incidents such as those related to the Love Canal in New York State and the Thames River in London provide examples of the horrors of poor management of industrial wastes. Similar stories about abandoned waste dump sites are found in other industrial countries of Europe, such as the Netherlands and the Federal Republic of Germany (UNEP, 1988). Given the long history of industrialization in both Europe and North America proper waste management was a

belated concern. The first European Economic Community directive on toxic and dangerous wastes, for instance, was enforced only in 1980 (Ibid.), and the United Kingdom adopted the directive as late as the mid-1980s. Consequently, many industrial countries are confronted with the problem of cleansing areas polluted with dangerous industrial waste at incredibly high costs (WCED, 1987; Allen, 1987).

The industrial world has now come to terms with the reality of unsafe disposal of wastes. Many have long realized that unsafe waste disposal is not compatible with high living standards and the ideal of high health standards. In the USA, for example, clean-up campaigns of hazardous wastes began as early as the 1960s, culminating in a shift of the issue from a local to a national scale issue. The latter was evidenced in the introduction of several statutes relating to environmental conservation, for example the Clear Air Act of 1970 and the Clean Water Act of 1972. Cleaning up of hazardous waste sites is a very expensive exercise. It is, therefore, generally accepted that prevention in the form of reducing the amount of wastes generated is preferable to after-the-fact cures. Allen (1987) noted that attempts to cure the problem of hazardous wastes by cleaning up disposal sites could cost from 10 to 100 times as much as would be the case if safe disposal of wastes were implemented from the beginning. The WCED (1987) estimated the cost of clean-up campaigns in selected industrial countries as follows (in U.S. dollar):

F. R. Germany	\$10.0 billion
The Netherlands	\$1.5 billion
United States	\$20 to \$100 billion
Denmark	\$60 billion

Evidence shows that the industrial countries produce most of the world's industrial wastes, or about 90 percent (WCED 1987). But, according to the World Commission, a large number of potentially hazardous wastes may also exist in the industrial urban areas of less developed countries, and thus require government action through regulation and financial support of waste disposal. It should be pointed out that most industries in

developing countries are of small or medium size. The World Commission found these to be among the worst offenders of environmental regulations in industrial countries. Since they have limited resources at their disposal, smaller industries are unable to afford the changes necessary to meet environmental regulations and product control (ibid).

Similar hardships can be expected of the majority of industries in developing countries. In view of the enormous cost of cleaning up old waste sites, it is advisable that these countries place a lot of emphasis on safe disposal of hazardous waste. This pre-emptive act will save them from the immense financial hardships caused by unsafe waste disposal clean-ups now experienced in industrial countries. The overall objective should be to reduce the amount of wastes generated. This can be achieved by recycling wastes and making them available for re-use, thus reducing the need for treatment or disposal through incineration, land disposal or dumping at sea (WCED, 1987; Anderson, Beiswenger, and Purdom, 1987). As a matter of fact, this should be a global effort because of the general shortage of land for human use including the disposal of wastes.

Even though the high ultimate cost of unsafe disposal of wastes may serve as an incentive against careless waste disposal, cost is not and should not be a primary concern in environmental management. It is the end results which are of greatest significance. The global concern is about a healthy environment and therefore action should arise primarily from perceived environmental and health costs rather than from financial costs. Human exposure to hazardous waste, for example, causes both immediate discomfort and long-term problems. Immediate effects of contact include rashes, burns, illness or poisoning while long-term effects include such chronic problems as lung disease, cancer, and genetic effects. The latter appear many years after initial contact (Conservation Foundation, 1984). This is particularly true of exposure to hazardous metals such as lead, copper, mercury, etc. The effects of exposure to lead are illustrative. Lead is primarily used in automobile batteries, gasoline additives, and paints. Human exposure to lead may occur through food or air.

It may also arise from old buildings painted with lead paint years before, particularly affecting children aged between six months and five years old. The ultimate results of chronic exposure to lead include anemia, convulsions, kidney damage, and brain damage (ibid). Many more hazardous materials are known to cause various adverse effects, ranging from simple skin irritations through cancer to genetic and birth defects.

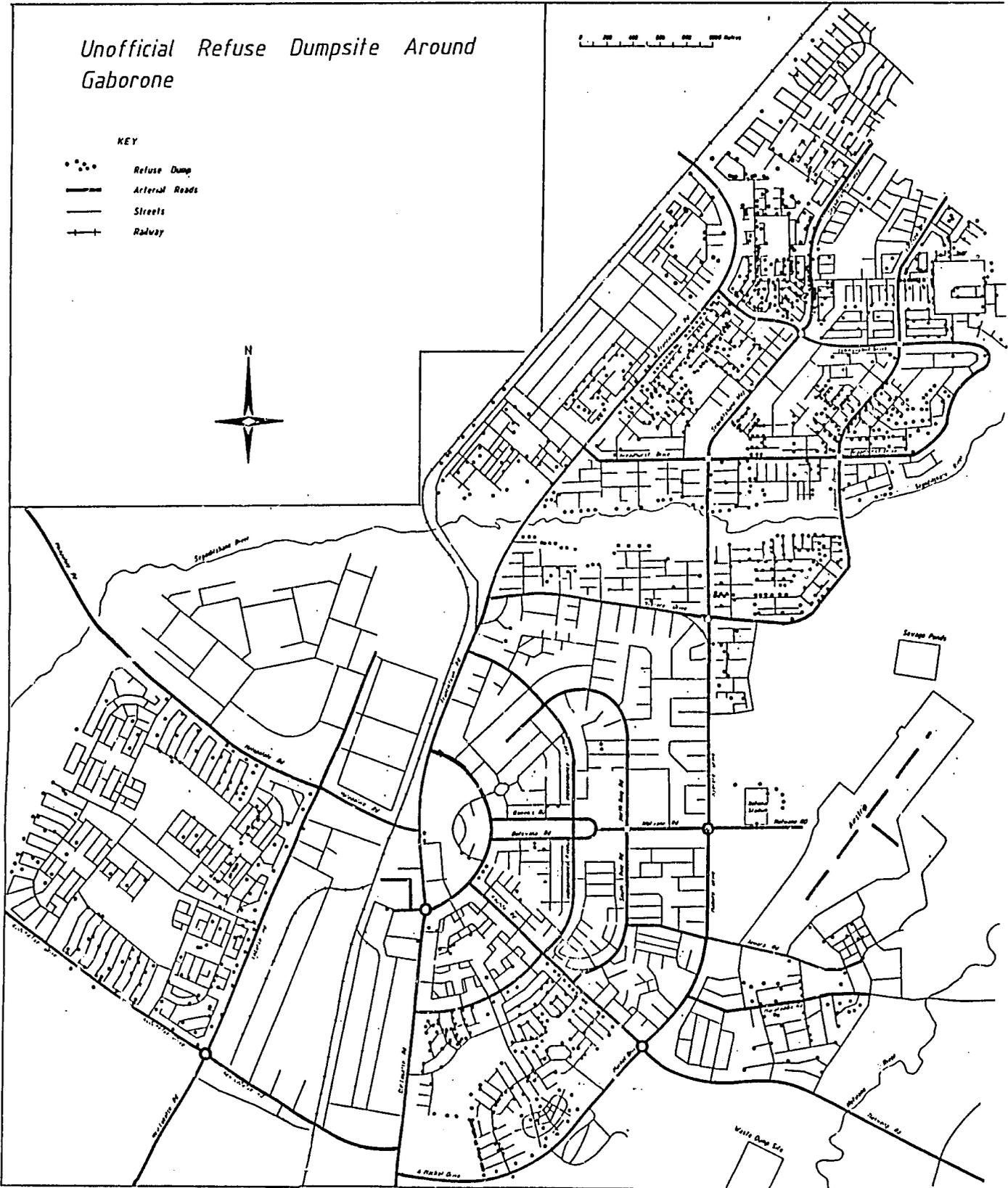
Environmental costs of unsafe disposal of wastes are also manifest in problems of environmental pollution. Concern here is based on the fact that pollution may reduce the resources available for human use of agricultural and residential land, water and vegetation. Such reductions compound existing pressures on resources exerted by rapid population growth in fixed total land areas.

The Botswana Situation in Historical Context. The first impression about current refuse and waste disposal in Botswana is that of a neglected sector. The unsightly situation of our roadsides and highways tells it all. Indiscriminate littering characterizes the country's highways, residential and commercial backyards, streets, and shopping centres. It reflects a typical scenario described in the "commons debate" in a reverse fashion (Brown, 1978). There appears to be neither care nor sensitivity to the problem of littering, and not surprisingly this attitude is extended to the general handling of refuse. Refuse is dumped in unsuitable places such as roadsides, destroying visual amenity of such places and becoming a public nuisance. (See Figure 1). Apart from being just a bad practice, the current attitude of handling refuse can be explained in an historical context. Goods and services provided in traditional Botswana were of different types and origins than is the case now. In the past, the amount and content of refuse generated were neither as big nor as diverse as is presently the case. Refuse mainly consisted of domestic wastes and agricultural by-products, most of which were bio-degradable. In other words, waste consisted mainly of organic materials. As a result, it did not really matter much how waste was disposed of because it could be dealt with by natural processes.

Figure 1

Unofficial Refuse Dumpsite Around Gaborone

Figure 1



Traditional Botswana also had a strong and effective social system to deal with refuse, particularly in the villages. Chiefs could give their people orders to clean up their villages and were in a position to enforce such orders. The orders of chiefs were enforced by selected regiments who could bring violators to the chief for reprimand and punishment. If the system was not always as effective as expressed here, the task of keeping villages clean was made relatively easy by smaller populations as well as by the smaller amounts of refuse generated. Thus, natural decomposition and nutrient cycling were not overwhelmed by the generation of excessive refuse. Consequently, refuse did not accumulate at a rapid rate. The role of population is well illustrated today in small villages, which are still relatively litter free. This correlation between increase in the generation of wastes and rapid population growth is also noted by Fabricant (1971), who observes that the greater the number of people and the higher their standard of living, the greater the amount of wastes they generate. On the basis of this it is apparent that a serious threat awaits Botswana, given its rapid population growth and economic growth.

Development trends in modern Botswana have drastically reduced the powers of the chief. Unfortunately, this has also inadvertently removed the sensitivity of the society to refuse disposal because such has always been the responsibility of chiefs. A new and less effective system has been put into place to assume responsibility for sanitation in major villages and urban centres. Even though modern health inspectors appear to do their job well, they possess neither the authority of the chief to impose punishment on culprits nor the necessary legislative authority to accomplish this. Instead, the current system is based on persuasion to arouse the conscience of the population to the problem of refuse disposal. While this appears to be a fair approach it is not the most effective. In fact, it may turn out to be detrimental in the long-run when the negative effects of current practices emerge. Modern Botswana requires a change in attitude and approach in ways of dealing with refuse. This is necessitated by the fact that the country now generates relatively larger amounts and

diversity of wastes. A rapid population growth of 3.4 percent and increases in industrial and commercial activities are responsible for this state of affairs.

Legislative Provision: The Central Government. The government of Botswana has enacted laws aimed at protecting the country's natural environment as well as ensuring acceptable environmental health conditions. These include the Public Health Act, the Atmospheric Pollution Prevention Act, and the Factories Act. These acts have gone a long way toward facilitating environmental health preservation. The Public Health Act, for instance, defines appropriate measures that should be carried out to control infectious and communicable diseases, their vectors, and a general lack of cleanliness. Particular attention is paid to lodging places, foodstuffs, and clothes. The Atmospheric Pollution Prevention Act seeks to regulate the emission of atmospheric contaminants in declared controlled areas (Department of Mines, 1978), for example mining and urban centres. The Factories Act defines appropriate measures that should be instituted to ensure the health, safety, and welfare of employees.

Despite the relevance of these acts toward ensuring acceptable environmental health conditions, all but one have the same shortcoming, that of not paying any particular attention to the role of industrial wastes in environmental pollution. Apart from the Atmospheric Pollution Prevention Act, none recognizes the need to regulate the disposal of industrial wastes. It is appropriate, for example, that the Public Health Act should be concerned with proper methods for handling and disposing of industrial pollutants. This is not the case in the present act. Instead, the act concentrates on nuisances caused by poor sanitary conditions. The same holds true of the Factories Act. The main concerns of the latter are safety and economics (i.e. employment creation, suitability of buildings, and financial capability of firms in question). Nowhere does the act address itself to industrial solid wastes as important constituents of environmental safety.

The issue of safe disposal of industrial wastes may not have been of immediate concern to industrial and health personnel during the pre- and immediate post- independence periods because of limited industrial activities. It may also be that at the time there was little understanding of the environmental implications of industrial wastes. But worldwide concern about environmental problems of industrialization has now increased our understanding of the problem. It is now better known that industrial activities are liable to produce undesirable by-products. Consequently, the types of wastes produced should be one of the concerns in issuing licences to prospective manufacturers. However, it is encouraging that the Atmospheric Pollution Prevention Act addresses the issue of industrial wastes as it is manifest in Selebi-Phikwe and in other declared controlled areas. A coherent system to monitor and regulate the emission of atmospheric contaminants has been developed

by the Department of Mines in the Ministry of Mineral Resources and Water Affairs. Its implementation gave rise to the Air Pollution Abatement Programme of the Bamangwato Concession Limited (BCL). Following this, there was better control of sulphur gas emissions from the smelter of the copper-nickel mine at Selebi-Phikwe (Department of Mines, 1978). The department operates several stations which measure sulphur concentrations in a number of declared controlled areas. Table 1 shows that the number of air pollution measuring stations has gradually increased between 1978 and 1986.

This growth in the number of stations has helped improve the monitoring of air pollution, particularly around the mine. Thus, the growth in the number of monitoring stations and the corrective measures taken thereafter help to explain the reduction in sulphur emissions around Selebi-Phikwe mine and township (Table 2).

Table 1. Air Pollution Measuring Stations in Selected Places

Place	1978	1986	1987	1988	1989
Selebi-Phikwe	7	10	10	10	10
Lobatse	0	1	1	1	1
Francistown	0	1	1	1	1
Morupule	2	2	2	2	2
Gaborone	1	4	4	4	4
Palapye	0	1	1	1	1
Total	10	19	19	19	19

Source: Based on information from Department of Mines.

Table 2. Reduction in Sulphur Dioxide Pollution Around the Mines and Township of Selebi-Phikwe ($\mu\text{g}/\text{m}^3$)

Station	1986	1987	Accepted Gov't
West of Smelter	690	640	N/A
Railway Track	250	190	N/A
Railway Station	110	80	N/A
GRB Hospital	N/A	200*	80

Source: Department of Mines 1986, 1987.

N/A = Not available.

* This is the only station out of a total of eight located in residential areas which reportedly recorded pollution levels above the accepted government standard. The other seven were within the acceptable level.

Air quality in other parts of Botswana is judged to be good with regard to sulphur dioxide concentrations. Sources of pollutants in most of these areas are said to consist mainly of wind-blown dust and smoke from cooking and heating fires (Department of Mines, 1978). However, atmospheric pollution nuisances were reported for Gaborone, which derive from sewage ponds located in the northern part of the city. Another cause of nuisance pollution is the burning of refuse on the dump site south of Gaborone.

A similar programme to prevent environmental pollution is lacking under the Factories Act of 1976. Even the Industrial Development Act of 1988 does not consider the ability to dispose safely of industrial wastes as a precondition for the issuance of an industrial licence. Instead, other criteria are used to refuse the granting of an industrial licence, for example that the applicant is a minor, or that a similar licence has been granted to some other person. All the acts referred to so far only provide a general framework for environmental protection. There is still need to develop a practical policy for environmental pollution control supported by guidelines which are not only elaborate but also assessable. This may come about with the completion and adoption of the National Conservation Strategy (NCS) currently under preparation by the Department of Town and Regional Planning in the Ministry of Local Government and Lands (MLGL). However, some departments have forged ahead in an effort to tackle the problem of pollution control. Most noteworthy is the Department of Water Affairs (DWA). The Department of Water Affairs has produced guidelines toward the prevention of water pollution. On the other hand, the DWA guidelines are not adequately comprehensive. They appropriately describe what should be done in terms of siting possible sources of pollutants in relation to water sources. Several waste-water disposal methods, which have recycling as their objective, are also suggested. Amounts of pollutants for various recipient sites are well defined. But the regulations tend to be more advisory to users than regulative of polluters. They do not, for instance, compel polluters to pre-treat industrial effluents before they enter the public sewers. The guidelines are

only presented as advice, since a monitoring system is not in place to track down and apprehend violators. This represents yet another gap in the present legislation which will probably be addressed by the NCS.

Given the differences in activities by the various government departments, it is clear that more environmental protection legislation is required. Some of the existing legislation needs to be improved, for example the Industrial Development Act and the Factories Act to include safe disposal of industrial wastes. The strength and effectiveness of these acts can only be realized through the preparation of appropriate guidelines at departmental level. What it means is that all departments whose present or future activities impact or are likely to impact the environment should prepare guidelines to reduce the likelihood of this occurring.

Legislative Provisions: Local Government.

The sanitation and wastes disposal authority does not fall under the ambit of the central government, but under local government, that is town, city, and district councils. Councils have developed by-laws governing the handling and disposal of refuse. Council by-laws on solid wastes are mainly directed toward residents; hence they concentrate on sanitary conditions around the house. For example they deal with ways of handling refuse bins. The by-laws do not attempt to make any distinctions among different types of wastes from the different sources (i.e. commercial, industrial, and domestic). Instead, "refuse" is used as an all-embracing term to cover all wastes. It is therefore evident that the council by-laws are incomplete for purposes of ensuring safe waste disposal. There is need to develop further specific by-laws that govern the handling and disposal of each category of wastes.

The Current Practice of Liquid and Solid Waste Disposal. Town and city councils, being the sole authority that control refuse, are also responsible for its disposal. Information obtained from the field shows that councils operate a fleet of vehicles and other equipment for the disposal of solid waste. They are also responsible for the planning, design, and operation of public sewers.

The subject of liquid waste management is not within the scope of this study. But proper disposal of liquid industrial wastes is important as liquids also affect natural resources, including water resources. The hazard of unsafe disposal of liquid wastes is shown in the problems that careless disposal of wastes has caused to Botswana's urban centres. A general feeling among sanitation authorities is that the management of liquid wastes is being carried out well, at least in terms of having waste water and industrial effluents run through a public sewage system to one destination. There are also conditions laid down to regulate the levels of pollutants allowed into public sewers. But their enforcement, and even the ability of the authorities to check for conformity through appropriate sampling and tests, are in question. Still, permission has to be sought from the local councils to discharge liquid waste into the public sewage system. Permission may be granted or refused subject to the conditions laid down by councils for granting such permission.

In an interview, the health inspector of the Lobatse Town Council was of the view that the town's liquid wastes are satisfactorily collected and disposed of through the sewage system to the oxidation ponds for treatment. Industries like the Botswana Meat Commission (BMC) are also reported to be satisfactorily managing their own liquid wastes, while the rest of the industrial, residential, and institutional properties are connected to the municipal sewage system. Some satisfaction with the handling of industrial liquid waste was also expressed by the factories inspector in the Ministry of Labour and Home Affairs. However, he admitted that the management of liquid wastes was not without problems, notably the disappearance of fish and reeds which used to be found in the pools of the Peleng river, and the closure of the boreholes which used to provide water for Peleng Village. In Gaborone it was reported that the direct disposal of oil into the city sewage system caused problems at the treatment plant, resulting in offensive odours affecting nearby residential areas.

The problem of oil may be particularly serious. Observation in the field revealed some instances where used oil from heavy machinery

and vehicles is allowed to run on the surface. Pollution of both ground and surface water may arise from this practice. It should therefore not be allowed to continue. A way must be sought to collect used oil for recycling.

These experiences with the disposal of liquid wastes may be indicative of more hidden problems in councils' sewage systems as well as the general disposal of liquid wastes. Hence, there is the need to tighten controls over liquid industrial waste disposal and management. Concern about the use of oxidation ponds, for example is relevant. These are employed for waste stabilization. While the process may reduce the deoxygenation of waste water, this may not be the case with industrial chemical pollutants. As a result the use of oxidation ponds not constructed with an impermeable bottom layer poses a serious threat to groundwater pollution problems which may have far-reaching health consequences for future users. Consequently, the satisfaction expressed by sanitation authorities may be based on superficial analyses, if not on the collection efficiency and mere disposal of liquid wastes. It may be that in-depth analyses of what actually happens to underground water aquifers are required. Satisfaction with collection and disposal should not lead to complacency but should lead to a closer examination of the composition of pollutants, particularly industrial pollutants.

Solid waste is a term used to refer to wastes frequently disposed on land such as sludges, slurries, and normal solids (Sercu, 1984). Their sources normally include food, clothes, cars, and building rubble. In many countries, solid wastes have been disposed of in several ways ranging from simple land tipping and burning through properly designed landfills to the complex method of incineration. The more complex methods of dealing with solid waste have not yet been developed or adopted in Botswana. Instead "crude" methods are still used. In Gaborone and Lobatse, land tipping and burning of refuse are the most used methods of disposing solid waste. This is probably true for Francistown as well.

Authority for the control, regulation, and disposal of solid waste lies with the district, town and city councils. Ideally they should possess suitable and adequate machinery to

undertake these tasks. Unfortunately, this is reported to be not the case. Included in their assignments is also the responsibility to identify and develop waste disposal sites and to manage them. For example, they decide on when tipping in a particular site should commence or cease.

As already indicated, none of the councils employs complex techniques for solid waste disposal. Instead "crude dumping" is utilized in excavated depressions. It is not clear what kind of engineering design has gone into these dump sites. In Lobatse, the site has been used for so long that the present authorities cannot tell whether its bottom layer has been constructed to impermeable status. Moreover, the council does not have a monitoring programme to detect groundwater contamination. According to the chief health inspector for Gaborone, the dump site here has been constructed with a semi-impermeable bottom layer. He admitted that only the underlying earth was exposed after excavation was compacted. No clay material was brought into the dump site to make the bottom layer totally impermeable, which is the standard practice in the construction of landfills to prevent leachate from percolating into the underlying rocks where it may pollute ground water aquifers.

Dumping of wastes takes place throughout the week. Both the councils' sanitation teams and private haulers bring truckloads of wastes to the sites where they are dumped, burned, or spread out. It is not clear how frequently the burning is carried out. What is clear is that the operation of the dump sites is neither regulated nor closely monitored, a situation which allows anybody to dump into the site any waste materials irrespective of their source and nature (Department of Mines, 1987). Open burning of these wastes leads to the release of complex contaminants into the air. Given that the refuse dumped at these sites ranges from domestic to industrial wastes, there may be toxic substances released into the air, including heavy metals. Air pollutants from the burning of waste with such a wide ranging composition may lead to serious health consequences for urban populations. A study carried out by NZA (1985) showed that the composition of wastes going into dump sites is highly varied and includes such things as organic material,

plastics, glass, tins, other metals, rubber, and paper. While burning is an acceptable method of disposing of wastes, what causes much concern is the simultaneous burning of different types of wastes in one mixture because the air pollutants that result thereof and their health effects are unknown.

One other area of concern has to do with the improper techniques employed at dump sites. In the case of the Lobatse dump site, information obtained from interviews shows that there is no daily application of earth to cover up the day's disposal. Yet this is essential to keep rodents, flies, and other pests from finding their way into the waste. Although it is not done on account of a lack of money to purchase proper equipment and machinery, covering of the day's disposal may also help to suppress offensive odors. It also improves the visual impact of dump sites. In Gaborone, the application of soil to cover the day's disposal is carried out infrequently. According to the chief health inspector, it is only done when construction companies have soil to dump at the site. This soil is then made available to the city council. In the event that companies do not have any soil to throw away, the covering of waste ceases.

The problem of lack of covering material is probably exaggerated because it could be managed through proper planning. NZA (1985) reported that building rubble was being dumped in the bush. Given that some of this may be composed of fine material, it can be used to cover dumps. Rubble could be brought to dump sites to be spread over the waste on a daily basis. If it is not possible to utilize all the rubble as it is being delivered, the excess could be stored nearby for later use. In fact this should be the case with all dirt waste. The development of properly dug and well designed landfills would allow the excavated material to be stored aside for later use. Adequate excavation will also prolong the life of the dump site.

The general lack of proper planning in urban waste systems is evident in the current use of the Maruapula sand pits as a waste dumping site. The pits resulted from the collection of sand for construction purposes. According to the Gaborone City Council Health Inspector, one of the reasons for using the sand pits as a dump

site is that they are often filled with water which seeps from nearby liquid waste stabilization ponds and are flooded during the rainy season. Children were attracted by standing water in these sand pits and they started playing in them. Unfortunately this led to a drowning. The immediate community response was to fill the pits to prevent such mishaps from recurring. Following this incident, waste disposal at the dump site south of Gaborone was halted. All the wastes are presently being disposed of at the Maruapula sand pits to cover them up.

Covering the pits was begun to safeguard the lives of children, and the use of readily available waste materials was probably the cheapest method of doing so. The problem could also be solved by filling up the pits with earth from elsewhere or by simply fencing them off. This would obviously involve extra costs. In any case, the decision to fill them up with waste of wide ranging composition could result in the contamination of groundwater aquifers underlying the sand pits. Past experience confirms this possibility. Jennings, for example, in Lewis (1976) reported the deterioration of boreholes in the Lobatse southern basin due to brine discharge from hide washings. This indicates how even distant sources of pollutants can affect groundwater. The long-term costs of groundwater pollution in a country endowed with minimal surface water could be great both financially and in terms of public health, and would far exceed any financial gains that might arise from the use of materials other than wastes to cover the sand pits.

Plans for Decommissioning. Even though council authorities acknowledge the need to make waste dump sites available for other uses on abandonment, no exact plans exist on how this will be accomplished. This is particularly true for Lobatse, where the present dump site is designated as part of an industrial site. The Lobatse Town Council does not have in hand an exact plan on how it will seal off or cover the current site to make it acceptable to prospective users. In Gaborone, according to the chief health inspector, some form of land restoration will be carried out at the dump site south of town. Restoration will involve returning the site to forest by planting it with trees, thus

giving it a natural look. No particular uses are envisaged for this site except that the trees planted on it will act as a wind break and thus shield the nearby trade fair grounds.

Given the current practice of waste disposal in Gaborone, where a wide range of wastes are brought to the same site, it is sensible that the site here is not intended for any direct use other than forest restoration. While this choice may help prevent direct contact of people with site contamination, it solves neither the problems of possible ground water pollution nor the imminent shortage of land in urban areas. For example, an interview with one of the health authorities revealed that the present residential site at B. C. Thema in Lobatse is located on an old dump. This siting was probably due to a shortage of alternative residential plots. Shortage of land here is also evident in the fact that the present dump at Lobatse has outlived its intended duration. In the view of the health inspector, it should have been abandoned long ago. Nevertheless, it continues to be used regardless of the health hazard it poses to nearby communities. In view of the inevitable shortage of land in urban areas and in order to address this problem, land-saving waste disposal techniques could be employed. Such techniques should include the use of properly designed landfills and the compaction of waste on a daily basis to reduce their volume and to prolong the lifetime of landfills. Proper plans for decommissioning should also be drawn so that waste land can be put to other public uses. Public parks and parking areas are among possible candidates for wasteland re-use. If the present system of waste disposal is continued without the implementation of component decommissioning plans, shortages of land will increase and much invaluable land will be laid in waste.

Despite an apparent awareness by the councils' sanitation sections of the inherent environmental health problems associated with unsafe waste disposal, they are constrained in dealing with the problem. The one problem is that the sanitation sections remain almost perpetually understaffed. More and better qualified personnel are required not only to reinforce the present workforce but also to have a direct input into the engineering of waste disposal facilities.

The other problem is financial. Interviews with sanitation staff in the councils revealed that failure to construct proper landfills and to cover daily disposals of wastes is not due to the ignorance of officers, but rather to financial constraints on the purchase of relevant equipment. Hence the planned new dump site for Gaborone will still employ land tipping following excavation. In Lobatse, the Department of Geological Survey (GS) has called for the safeguarding of groundwater aquifers through the construction of proper landfills (personal communication with Health Inspector LTC). The GS was reported to have recommended that the proposed new dump site for Lobatse should be completely sealed off with a layer of impermeable material at the bottom. Unfortunately, Lobatse Town Council could not adopt the recommendation on account of cost. This is a rather short-sighted choice because it disregards the long-term environmental implications of pollution.

It is generally apparent that the proper disposal of industrial solid wastes in Botswana is constrained by improper management techniques, by inadequate financial support, by a lack of appreciation of the long-term environmental costs of pollution, and perhaps by mere indifference. Failure by the authorities to provide adequate financing for this important undertaking is illustrative. The need to pay now for safe waste disposal cannot be over emphasized because remedial measures in the future will cost much more (Allen, 1987; W.C.E.D., 1987).

METHODOLOGY

In order to substantiate this conclusion, data on official practices, legislation, and policies relating to industrial waste disposal were collected from relevant government officials in the Ministry of Local Government and Lands, the Ministry of Health, and the Town Councils of Francistown, Lobatse and Gaborone. A list of operating industries was compiled for each town. For this purpose a computer print-out of the official registry was used. This preliminary roster was supplemented with companies listed in the telephone directory and noted on town and plot

maps. Field checks and observations were subsequently carried out to verify the locations and operations of the companies. On the basis of these checks, a final list was prepared of establishments which are likely to produce substantial quantities and/or special types of waste materials. Those that were likely to produce only very small quantities of wastes, such as most small shops and retail outlets, as well as those unlikely to produce any waste materials, such as accounting firms and bible colleges, were excluded from the list.

Each institution on the list was informed about the survey by letter. Management was then approached with a standard interview schedule which included questions on:

- details of the enterprise, including location, types of products and processing techniques, etc;
- types and quantities of waste materials, with special attention paid to solid wastes;
- present methods and locations of waste disposal;
- problems of current waste disposal methods and alternatives as seen by management;
- attitudes of the management towards waste disposal problems and alternative solutions, with emphasis on the legal aspects, costs, and possibilities of recycling;
- awareness of management concerning existing city/town by-laws and other rules pertaining to waste disposal.

A supplementary questionnaire was designed especially for municipal waste authorities (City and Town Councils). It was intended to elicit information on the exact nature of operations and methods of waste disposal. In addition, discussions were held

with individuals from various government ministries and departments.

A total of 187 interviews were completed, during the period of June to August 1989, by six interviewers who were all third-year students in the Department of Environmental Science of the University of Botswana. One research assistant was employed to supervise the interviewers. The data were analyzed through the SPSS computer programme.

FINDINGS OF THE COMPANY SURVEY

A closer look at the state of the art indicates that waste disposal techniques employed at independence have not changed much. Yet all indications point to an ever-increasing capacity to generate larger amounts of waste than before. NZA (1985) estimated that waste from all sources would double by 1995. In this estimate, the quantity of commercial/institutional waste will change from 17 tonnes per week in 1985 to 33 tonnes per week in 1995. Industrial waste will increase from 21 tonnes per week to 41 tonnes per week in the same period. Even though the exact proportions cannot be confirmed, sizable increases in the amount of waste can be projected in a number of ways.

One way to measure increases in the amount of waste is in the proliferation of unofficial

waste dumping sites in urban areas. While this problem is not peculiar to urban centres, it is most noticeable here because urban areas are provided with waste disposal facilities. The increase in unofficial dump sites may be indicative of a failure by municipal waste authorities to bring waste disposal under control. Waste drums, skips, and bins remain unemptied for long periods of time and this encourages waste to be dumped at any convenient place (See Figure 1). Another relevant inference may be derived from the fact that the proportion of waste deposited by the Gaborone City Council has increased. NZA (1985) reported that the council deposited 70 percent of refuse at the dump site. One of the municipal waste authority personnel, in a 1989 interview, suggested that the council was responsible for dumping 90 percent of the waste.

Types of Wastes. Many different types of wastes are generated by the industrial sector in Botswana. Ranking high among these are wastes that are of metallic and chemical origin. Table 3 provides a classification of such byproducts according to source. It is clear from the table that the most common wastes are of metallic and chemical origin. These are followed by plastics and organic products. The total number of waste materials from different sources exceeds one hundred.

Table 3. Categories of Wastes Generated by Industries

Category of Waste Product	Number of Companies	Percentage %
Metals and Metal products	35	33.0
Chemicals & Chemical Products	30	28.3
Plastic & Plastic Products	8	7.6
Glass and Glass Products	5	4.7
Rubber and Rubber Products	1	0.9
Petroleum Products	5	4.7
Bitumen, Tar, Coke Ash, & Burned Coal	5	4.7
Waste Water, Sludge, Slag	4	3.8
Gases	4	3.8
Organic Products	8	7.6
Asbestos Dust	1	0.9
Total	106	100.0

Source: Based on information obtained from interviews.

In Table 4, the particular characteristics of waste materials are considered, including those that are known to cause adverse short- or long-term effects on the environment. Respondents were asked to list the different types of wastes they generated according to volume. In most cases, more than two types of byproducts were generated but only the two major ones are presented in Table 4. It should be emphasized, however, that small amounts of waste are not necessarily less hazardous. In fact the contrary may be true. This is evident in Table 4 where the proportion of companies which admitted generating toxic wastes is higher in the second most important waste product category (15.1 percent) than in the major category (12.0 percent). A similar trend is apparent concerning combustible waste products.

Contrary to the NZA (1985) report that no industries admitted to producing toxic wastes, in this study a considerable number of companies (12 percent) admitted to producing toxic materials. This confirms the suggestion by

the Department of Mines (1986 and 1987) that some of the wastes produced in Gaborone may be toxic. Most of these wastes are not disposed of in any special way, and it is evident that not only is the quantity of waste generated in Botswana's urban centres increasing, but so is its diversity and the danger it poses to the environment.

Table 4 further reveals that a large proportion of companies generate solid waste (73.4 percent). A larger proportion of these materials, according to nearly two-thirds of the companies (57.4 percent), is non-degradable. A little over half of all the companies (51.6 percent) produces wastes which are not considered combustible. Also shown in the table is the fact that a few companies, 0.5 percent to 1.6 percent, indicated that they did not know whether their wastes were toxic or not and degradable or not. This is true for both of the two major waste products. There are two possible explanations for this response. It could be that the companies' respondents were

Table 4. Proportion of Companies Generating Wastes With Selected Characteristics

Waste Characteristics	Major Waste Product	Second Waste Product
	Proportion of Companies	Proportion of Companies
Solid	73.4	71.7
Liquid	20.1	24.4
Gas	2.7	1.6
Other	3.3	2.4
Toxic	12.0	15.1
Not toxic	86.4	83.3
Partially Toxic	0.5	N/A*
Don't Know	0.5	0.6
Combustible	46.7	47.6
Not Combustible	51.6	51.6
Other	1.6	N/A
Don't Know	N/A	1.6
Degradable	39.9	40.9
Not Degradable	57.4	57.5
Other	1.1	N/A
Don't Know	1.6	1.6

Source: Based on Information Provided by Companies.

N/A = Not Available.

playing it safe or they could be genuinely ignorant. Whatever the case, there is need for both the producing companies and the waste disposal authorities to know the nature of the wastes generated. This calls for close monitoring of the situation by the appropriate government department through relevant tests.

Earlier in this paper it was pointed out that the handling of liquid wastes is better developed than that of solid wastes. Given that Table 4 shows that more companies generate solid wastes than liquid wastes, the need to provide appropriate infrastructure and facilities for solid waste management cannot be over-stressed. Solid wastes pose a threat to both environmental health and the visual appeal of the human environment. Therefore, special attention is essential in dealing with solid wastes and particularly toxic solid wastes.

Responsibility for Waste Disposal.

Information obtained from interviews with company managers shows that there are several organizations involved in the disposal of wastes. The findings of this study contradict the NZA report (1985) and also the suggestion by one of the Gaborone City Council health authorities (1989) that the City Council is responsible for disposing 70 percent and 90 percent of the city's wastes. In this study, 50.8 percent of the companies claimed that they were responsible for dumping their own wastes, while only 20 percent said that the government or council was responsible. Nearly 15 percent of the companies indicated that they used "other" methods (see Table 5). However, the difference may be explained by the fact that this study considered wastes generated by selected companies, while NZA and the City Council considered the totality of the city's refuse.

Table 5. Responsibility for Waste Disposal

Waste Disposers	Number of Companies	Percentage %
Own Company	93	50.8
Another Company	6	3.3
Government/Council	37	20.2
Own Co. & Gov't/Council	12	6.5
Another Co. & Gov't/Council	4	2.2
Other	27	14.8
Not Applicable	4	2.2
Total	183	100.0

Source: Based on Information Provided by Companies.

Manner or Places of Waste Disposal.

Information provided by company managers shows that different methods are used for waste disposal. The most striking responses are those in which companies indicated that they disposed of wastes in their plots, or used other places for disposal, or were not sure, or did not know where the wastes were disposed. All considered, about one-third of all companies

gave these responses (see Table 6), which immediately raises the question of what happens to the wastes. This uncertainty in turn raises concern about waste disposal without regard to environmental factors. It is evident from Table 6 that nearly half of the companies use places for disposing of their byproducts other than the official dump sites.

Table 6. Manner or Places of Waste Disposal

Place	Number of Companies	Percentage %
Own Plot	6	3.3
Official Site	99	54.1
Drains	6	3.3
Atmosphere	4	2.2
Sold	6	3.3
Official Site & Atmosphere	1	0.5
Official Site & Sold	1	0.5
Not Sure	1	0.5
Don't Know	6	3.3
Other	48	26.2
Not Applicable	5	2.7
Total	183	100.0

Source: Based on Data Obtained from Field Interviews.

Frequency of Waste Disposal. This study found out that the frequency of waste disposal is varied. At the one extreme, some companies indicated that their wastes are disposed of continuously. At the other extreme, others said

yearly. Table 7 shows that two-thirds of the companies (63.7 percent) had their wastes removed on a weekly basis or more frequently. The rest had theirs removed less frequently.

Table 7. Frequency of Waste Disposal

Frequency of Disposal	Number of Companies	Percentage %
Continuously	7	3.8
Daily	54	29.2
Weekly	55	29.7
Monthly	48	26.0
Yearly	13	7.0
Don't Know	5	2.7
Other	3	1.6
Total	185	100.0

Source: Based on Field Interviews.

Waste Monitoring. Even though the councils have legislation governing the handling of "refuse," no regulations have been developed to effectively monitor the handling and disposal of waste in an acceptable manner. Existing legislation, as already indicated,

lacks sufficient emphasis on environmental pollution control. Even at the national level, laws relating to the prevention of environmental pollution are mainly in the form of general acts. No regulations for the handling of specific wastes and particularly hazardous

wastes, have been developed. Consequently, the legislation fails to provide specific guidelines to regulate companies.

There also appears to be a communication and/or information barrier between the authorities and the companies involved. Asked about their knowledge of national acts dealing with waste disposal, only 33.9 percent expressed awareness, while 65.1 percent said they were not informed. In relation to the council by-laws, 45.7 percent of the respondents indicated that they were familiar with them while 53.2 percent said they were not. In both cases more than half of the respondents were not familiar with legislation intended to bring about control of environmental pollution. This indicates an apparent deficiency either in the legislation, or in its implementation, or in both. In response, more than half of the respondents felt that more laws were required or that existing laws needed improvement. Only 10 percent of the respondents expressed a contrary viewpoint.

The study found that the inspection of companies is also highly irregular. When asked whether they were ever visited by an inspector, most respondents (71.5 percent) acknowledged having been visited by an inspector while 26.9 percent responded

negatively; but it is clear from Table 8 that factory inspections are not conducted on a regular basis. The table indicates the frequency with which factories are inspected. One quarter of the respondents stated that their firms were visited once a year. About 11.8 percent were visited twice a year. Only 4.3 percent of the total number of respondents indicated that they were visited regularly. Furthermore, less than half of the respondents (43.8 percent) indicated that they were visited by an inspector in the last six months. Such a loose and irregular system of inspection is partly to blame for a lack of commitment to the control of environmental pollution. This is because under these circumstances, people will act out of convenience when dealing with waste disposal, particularly when disposal is left to the conscience of those who generate wastes.

The safe disposal of wastes is thus made difficult by inadequate law enforcement. A large number of respondents felt that council by-laws were not adequate. For example, 33 percent felt that the by-laws needed improvement, while 5.9 percent said they were totally inadequate, and only 17.3 percent felt they were adequate. It is therefore evident that something has to be done about legislation relating to proper waste management.

Table 8. Frequency of Visits by Factory Inspector to Firms

Number of Visits per Year	Frequency	Percentage %
Less than once a year	6	3.2
1	47	25.1
2	22	11.8
3	8	4.3
4	10	5.3
5-6	4	2.2
7+	6	3.2
Regularly	8	4.3
When license is renewed	7	3.7
Not often	5	0.7
Not Sure	10	5.3
N/A	54	28.9
Total	187	100.0

Source: Based on Field Interviews.

Company Managers' Awareness and Attitude Toward the Problem of Industrial Waste. Most company managers expressed awareness of the problem posed by unsafe disposal of industrial wastes. Up to 97 percent of the managers think that proper disposal of wastes is essential, while only 1 percent express a contrary viewpoint. An even larger proportion (98.9 percent) think that safe waste disposal should be required of all companies operating in Botswana. Only 0.5 percent of the respondents had a contrary viewpoint. And 99.5 percent are of the opinion that law enforcement should be applied to all wastes, even if they may not be necessarily harmful.

Conviction among the respondents that something has to be done about industrial wastes is evident in the fact that they do not change their minds when confronted with the question of cost. About 98.4 percent of the managers think that all companies should be required to observe requirements for safe disposal of wastes regardless of the cost implications to the companies. Asked who should pay for the cost of safe disposal of

industrial wastes, 50 percent of the respondents thought the companies should pay the cost while only 6.5 percent thought the government of Botswana should pay. It is evident from Table 9 that while half of the respondents think companies should pay toward the cost of safe waste disposal, they nevertheless feel the government and councils have a part to play as well. For example, when asked whether the companies would be willing to pay for part or all of the costs, 59.5 percent expressed willingness to pay for part of the cost while only 31.4 percent were willing to pay for all the cost. Only a small minority in the industrial community (4.9 percent) was not prepared to contribute toward improved waste management. Asked who should meet the other part of the cost, most companies (70.8 percent) thought the government should. But 25 percent did not think the government should be involved. Furthermore, 56 percent of the respondents expressed willingness to contribute to a public waste treatment plant, while only 34.1 percent were not for the idea.

Table 9. Opinions of Company Managers About Who Should Pay for the Cost of Waste Management

Responsibility to Pay	Frequency	Percentage
Company	92	50.3
Government	12	6.6
Council	11	6.0
Public	7	3.8
Company and Government	31	16.9
Company and Council	16	8.7
Company and Public	7	3.8
Government and Council	3	1.6
Council and Public	1	0.6
Don't Know	2	1.1
Other	1	0.6
Total	183	100.0

Source: Based on Field Interviews.

There is no doubt that companies are aware of the problems associated with industrial wastes. Most companies are also willing to pay for part of the cost of industrial waste management. Even so, their level of comprehension of the problem leaves much to be

desired. Most companies, for instance, seem to be content with present waste disposal practices. Out of the total number of managers interviewed, 78.1 percent felt that the methods of waste disposal in practice are adequate and only 16.6 percent did not think so. A few of

them thought the disposal system was not always adequate. Furthermore, most companies indicated that they did not have problems with waste disposal. This is obviously an internal assessment of the situation within the company and lacks an outlook into what happens once the waste materials have left the firm. The latter is something that can be brought into the people's awareness through education and effective government policy. Here there is ample opportunity to cooperate with industrial firms to improve waste management. It remains for the authorities to capture this opportunity while there is still the will. Timing is critical, because no government will escape the blame in the future should adverse environmental and health effects arise from poorly developed waste management systems.

Government and Local Councils. The authorities are quite aware of the problems associated with industrial wastes. This is made evident by the fact that environmental pollution control is one of the objectives of the envisaged National Conservation Strategy. Also, in late 1988 the Government of Botswana rejected a request from a foreign company to dispose of industrial wastes in Botswana. According to one official in the Ministry of Local Government and Lands, the company claimed that wastes were "inert." In refusing to agree, the government showed understanding and good foresight. In addition, officials from other government ministries and departments have expressed concern about possible environmental pollution resulting from the current economic boom in Botswana.

Local councils expressed no less concern about hazardous wastes. In the words of the health inspector for the Lobatse Town Council, "waste management in Botswana generally is crude and therefore, whether toxic or not, is a nuisance and remains hazardous to the public." Furthermore, the health inspector meetings of September 1989, held in Lobatse, recommended a law to govern the disposal of toxic wastes. The health inspectors not only called for a strict law, but also for its vigorous enforcement to save the environment.

But being aware of the problem and not doing much about it is not any better than not

knowing about it. The intended new waste dump site at Lobatse is a case in point. Another indication is the continued use of poorly designed solid waste dump sites and deliberate plans to continue crude dumping on account of cost limitations. Yet another indicator is the continued failure to cover the daily disposal of wastes in both Gaborone and Lobatse. This lapse is allowed on account of cost and lack of equipment, and not because health inspectors are unaware of the health implications of such operations. What is required is more than awareness; it is commitment and the will to act. Financial constraints may be genuine, but they should be weighed against long-term financial costs and environmental effects.

A SUMMARY OF THE PROBLEMS OF WASTE MANAGEMENT

Certain inherent problems characterize the Botswana waste disposal situation. Unless these problems are addressed, the problem of environmental pollution will remain intractable. Any system of waste management that is developed without paying due regard to these factors is likely to bring little success if not complete failure. This is because there are signs that even though the problem of industrial pollution is not yet acute it is likely to increase. The following are factors responsible for this trend.

1. The economic boom, which has characterized Botswana since the start of mineral development, continues to attract an increasing number and diversity of industries. This increase is bound to generate ever larger and more diverse amounts of wastes.
2. Crude methods of waste disposal are still in use, for example, land tipping of all types of waste into ill-designed landfills.
3. A lack persists of a well coordinated institutional

framework for the control of environmental pollution.

4. Authorities are inclined toward saving immediate financial cost at the risk of long-term environmental effects.
5. A limited competence to classify and distinguish between hazardous wastes and those that are not hazardous exists among both government officials and company personnel.
6. The country suffers from poor legislative provisions and a lack of specific regulations to govern the handling and disposal of the different types of wastes.
7. The industrial licensing system is based mainly on economic factors and safety of the workplace, not on environmental concerns.
8. The recycling of byproducts to reduce wastes is still quite limited.
9. Law enforcement to ensure compliance is inadequate.

POLICY RECOMMENDATIONS

In order to overcome the problems of industrial wastes, the government must develop a clear policy to regulate industrial growth according to accepted environmental standards. The following policy reforms are among those recommended.

1. Assurance of adopting acceptable waste management and disposal methods must be one of the preconditions for allowing factories to operate in Botswana. Companies dealing

with potentially hazardous materials must be required to notify the authorities about such wastes and their expected quantities. They should also suggest a method of disposal. During operations, companies should also be required to maintain actual records of generated wastes in order to keep the authorities informed.

2. The adoption of new and effective methods of waste management should be achieved through properly designed landfills and wastewater treatment plants. Suitable operations should be carried out to enhance the effectiveness of these techniques, for example close monitoring of dump sites to ensure that only the allowed materials are brought to the site. Close monitoring will also ensure that the landfills are used only for their planned duration. Authorities must also prepare comprehensive plans for decommissioning.
3. Coordination should be exercised between the various government agencies involved in pollution control, to define and ensure sound management of environmental wastes.
4. Coordination should likewise be exercised between the authorities responsible for the promotion of industrial development and those concerned with environmental protection.
5. Definition of the waste-management responsibilities of companies vis-a-vis central government and local councils should be clarified.

6. Trade-offs should be made between the short-term financial savings of crude methods of disposal and the long-term benefits of sound environmental management.
7. Training programs should be devised to produce competent personnel capable of classifying and separating hazardous materials from those that are not.
8. Legislation should be enacted to govern the timely identification of future dump sites. Sites should be identified on a waste-type basis.
9. The present system of industrial licensing should be broadened beyond economic and job safety criteria to include environmental pollution factors. This could be facilitated through new provisions in both the Industrial Development Act and the Factories Act.
10. Recycling of byproducts should be encouraged to reduce the quantities of wastes generated. Byproducts which can be recycled include scrap metal, broken glass, plastics, cans, papers, and oil. A small payment could encourage people to help in the collection of these byproducts.
11. Law enforcement should be enhanced to ensure compliance. This could be made possible through introduction of penalties that could be easily and quickly administered by law enforcement officers.
12. Legislation should be introduced to deal with the transboundary transfer of hazardous wastes. The high cost of eliminating hazardous wastes is likely to turn dealers in hazardous wastes to countries, like Botswana, that are ill-prepared for them.
13. Consideration should be given to the use of licensed waste haulers to ease the workload of municipal authorities. This arrangement could also enhance control of waste disposal by reducing the number of individuals who currently practice waste disposal on a self-help basis.
14. Policy should be developed to control environmental pollution and should be supported by guidelines which are both comprehensive and measurable. This policy should apply particularly to major villages in view of the government policy to encourage industrial development in rural areas.

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