OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

18809

Distr.
LIMITED

ID/WG.507/9(SPEC.)
29 November 1990

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Regional Meeting on Management of
Industrial Waste Water

Paris, France, 10-14 December 1990

PROGRAMME ON PURIFICATION OF INDUSTRIAL WASTE WATER

Technical Report*

Prepared by

L. V. Brynolf and T. Murawski

UNIDO consultants

S/ 32

* The views expressed in this document are those of the authors and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been formally edited.

V.90-89893

CONTENTS

Annexes

Tables

ABBREVIATIONS

BMC	Botswana Meat Commission
BOD_5	biochemical oxygen demand (measured in days);.a measure on the demand of oxygen in water from the mineralization of (polluting) organic matter in it
COD	a measure similar to BOD: includes some inorganic matter
NPDES	National Pollutant Discharge Elimination-System
N-tot	measure of total nitrogen (in water)
PTA	Preferential Trade Area for Eastern and Southern African States
P-tot	measure of total phosphorous (in water)
PCB	polychlorinated biphenyl
pH	measure of the hydrogen ion concentration in water (acid, neutral or basic water)
ppm	parts per million
SIDA	Swedish International Development Authority
SS	Suspended solids. Measure of solid matter suspended in water.
TDS	Total dissolved solids (in water)
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNIDO	United Nation Industrial Development Organization

SUMMARY

Seven African countries participated in the Programme on Purification of Industrial Wastewater (Phase I): Botswana, Ethiopia, Lesotho, Uganda, United Republic of Tanzania, Zambia and Zimbabwe. The objective of the programme was to examine existing industrial wastewater treatment efforts and make recommendations for improvement at both policy and plant levels. In each country, during March and April 1990, preliminary studies were carried out by national experts working within or in liaison with government ministries and departments charged with monitoring and control of water use and industrial wastewater discharge. Two UNIDO consultants augmented the studies, visited numerous industrial facilities, and drew general conclusions on all seven countries during a joint mission which took place between May and August 1990.

The studies covered mainly the technical aspects of the present and projected situations in specific industries with regard to water use, wastewater treatment and industrial technology, with particular attention to the environmental aspects of all of these. The industrial sectors covered were all agro-based: abattoirs, breweries, sugar, tanneries, and textiles. The studies also included information on the legal and institutional aspects of water use and the control of pollution from wastewater originating from industrial sources. Finally, the consultants examined existing laboratory resources and assessed the need for training programmes on the methods of and facilities for wastewater treatment.

This document, together with the preliminary country-specific studies prepared by the national experts, forms the basis for a workshop to be held in Paris between 10-14 December, 1990 with participants from the seven countries. At the Regional Workshop on Management of Industrial Wastewater, recommendations for future action to be carried out in a proposed Phase II will be outlined and discussed for the five sectors involved.

The following major conclusions were drawn from Phase I of the programme:

Overall, much of the industry in the sectors examined is outdated. The methods and processes employed are causing over-use of water and most have not installed even the most basic wastewater treatment processes. In areas of industrial concentration, the environmental and health impacts are serious. Monitoring of both water use and wastewater discharges has not been carried out, and water data are themselves very scarce. This complicates matters and hinders attempts to find solutions.

Comprehensive action is required. Wastewater management could be improved in all industrial subsectors if public sewerage systems were to be established which could receive pre-treated industrial effluents. Other measures could also contribute significantly to alleviating the problem. Alternative possibilities for disposing of industrial wastewater discharges include methods such as irrigation and evaporation. Chrome present in tannery effluents should be removed by precipitation and the chrome-containing wastewaters recycled. In other industrial subsectors, by-products should be recovered and re-used, or composted where possible. Examples are paunch-contents and bone- and carcass-meal from abattoirs, and spent grain from breweries.

The present capacity of existing pollution control inspectorates (or their equivalent) in each country is too low. Existing ones should therefore be strengthened and in cases where none exist, new ones established. Polluting industries should be required to obtain permits stipulating level and type of pollutants allowed to be discharged, based on national wastewater treatment and effluent control standards to be elaborated or strengthened. The industries should monitor the pollution discharges and be required to keep detailed records for inspections. Standards should be enforced to the fullest extent possible.

Referral water quality and pollution control laboratories are inadequate and should also be strengthened where possible or new ones established. General training and pilot projects should be designed and implemented, mainly for middle-management staff in government authorities and industry. In addition, some technical training programmes in monitoring techniques and the operation of wastewater treatment plants would be useful.

I. INTRODUCTION

1. The programme began with the following assumptions:

a) Water resources in developing countries are essential for human domestic, agricultural, and industrial development;

b) These resources are limited in magnitude and have a limited capacity to absorb pollutant loadings;

c) Water and land resources are subject to increasing exploitation, environmental degradation, and depletion. Among the factors involved are:

(i) high population growth rates;
(ii) high urban growth rates;
(iii) increased agricultural activities required for self-sufficiency and cash crops;
(iv) decreased and/or increased acceleration of industrialization;

d) Degradation of water and land resources reduces availability of resources, even as demand continuous to grow.

e) Water scarcity can be anticipated and, in the interest of sustained development, appropriate action can be taken to prevent a crisis.

f) One action that can and should be taken immediately is to manage industrial water use and wastewater discharge from industry.

2. In consideration of the above, and in view of limited time and resources, it was decided that the programme would best accomplish its objectives if it were to focus on a few countries and a limited number of industrial sectors. Therefore, a number of Anglophone countries of eastern Africa were invited to participate in the programme. Botswana, Ethiopia, Lesotho, Uganda, United Republic of Tanzania, Zambia and Zimbabwe accepted the invitation. The selection of industrial sectors was narrowed considerably to include only agro-industries with well-known environmental problems. The following sectors were chosen: abattoirs (slaughterhouses), breweries, tanneries and leather industries, textile industries and sugar industries. In addition, examples of sisal industries and pesticide formulation plants were included in some countries, and fertilizer production plants also later proved of particular interest.

3. The immediate objective of Phase I of the programme was to enable the participating countries to adopt policy measures to deal with the long-term environmental problems related to industrial water pollution. The intention was to proceed into a second phase comprising operational meetings for training and development of projects.

4. In each country, the national experts investigated water use and wastewater generation in selected industrial facilities in the industrial sectors chosen. They then prepared country studies containing extensive descriptions of the situation for each type of industry. Information included number of plants, type of wastewater treatment, environmental impact, etc. This preliminary overview formed the basis for the continuation of the work, carried out by the international consultants. A list of the country studies can be found in the bibliography, which contains lists of all reference materials used in preparing this document.

5. The following national experts were involved:

Botswana:	Mr. F. Magibisela
Ethiopia:	Mr. D. Mebratu
Lesotho:	Mr W. K. Kariuki and Mr. F. K. Masilo and Mr. F. M. Mpendazoe
Uganda:	Mr. N. Droruga
United Republic of Tanzania:	Mr. F. Gumbo, Dr. D. A. Mashauri, Mr. S. S. Mkuula,
Zambia:	Mr. Z. Phiri
Zimbabwe:	Mr. B. C. Chiworeso

6. Two international consultants engaged by UNIDO spent approximately two weeks in each country between May and August 1990, working with the national experts and evaluating the situation

for each of the subsectors, reviewing the technical options and determining appropriate regulatory measures for industrial wastewater treatment. One of the consultants was a technical expert in wastewater treatment, and the other was an expert in environmental economics. The technical expert also identified training needs on methods to be used and facilities required for wastewater treatment, and was in addition able to recommend two specific demonstration plants which could be used for training purposes.

7. In carrying out their assignment, the consultants conducted both field research and analysis of the subsectors. This document should be viewed as a summary of the field visits and country studies. Many of the country-specific and industry-specific comments and recommendations made in the preliminary country studies produced by the national experts in each country have been incorporated.

8. The next major step in Phase I of the programme consists of presentations and discussions at a workshop to be held in Paris, between 10 and 14 December 1990, in conjunction with the Industry and Environment Office of the UN Environment Programme (UNEP). These will be based on the findings and recommendations reached thus far. A report will be prepared on the outcome of that workshop and a project document for Phase II will also be elaborated based on the results of Phase I.

II. OVERVIEW AND SELECTION OF INDUSTRIES

9. Assessing priorities in the selection of industrial subsectors varied greatly among participating countries. Some countries were consciously selective and included only those industries and individual plants which are of most concern environmentally, while others chose to cover almost all industries in which water pollution was a problem. However, whatever their criteria of selection, all contributed with enthusiasm and provided as much relevant information as was possible to obtain.

10. One country, Zimbabwe, reviewed the proposed agro-based industries the programme was to cover and found that as the industrial wastewater discharges in those five sectors were all already connected to public sewers, they no longer posed such a serious pollution hazard. Therefore, for the most part, the Zimbabwean national expert substituted examination of industries in the mining/metals and fertilizer sectors.

11. A compilation of the visits made by the consultant to industrial plants, water and sewage works and laboratories is presented in table 1. A more comprehensive table, including the industries discussed in the country studies, is shown in table 2. The consultants were selective in their choice of plants; it was difficult to include too many visits to individual industrial facilities due to lack of time. Table 3 records data collected on production, water use and effluent characteristics in the five industrial subsectors. Tables 4 and 5 indicate how a natural selection evolved from the experiences of each of the countries: based on measures of prevalence of environmental damage and pollution load, the most significant agro-based industries were found to be abattoirs, breweries, sugar, tanneries and textiles. In this Programme these five sectors combined account for approximately 78 percent of the industries discussed in the country studies and 73 percent of the industries visited by the consultants.

12. In determining which industrial sectors would be the focus of the programme, a further requirement evolved: that there be a possibility of initiating effective action to counter water pollution. Because of this added criterion, textile industries were set aside for the time being. They certainly consumed large quantities of water and generated severe pollution, but they were more complex than the other four industries. For the most part, the equipment utilized determined to a great extent the anticipated environmental difficulties, and the anti-pollution measures required in textile industries were advanced and costly. More information on this can be found in chapter IV.

13. Not many sugar plants were included in the analysis; in some of the countries they were not present at all. Where they did exist, they were normally large. Where water recycling and wastewater treatment were not properly addressed they had a very strong negative environmental impact on the surrounding area. Unfortunately, the consultants could only visit one sugar factory, in Uganda, because of lack of time and transportation and the fact that the visit was made in the off-season. However, that one facility provided a good example of recycling of various water streams. If a wastewater treatment plant for the sugar industry were to be included at some later stage of this programme, this facility could serve as a model for demonstration and training.

14. As a result of the above selection, at this stage of technical consideration in the programme the emphasis has been on abattoirs, breweries and tanneries; the sugar and textile industries have been touched upon more lightly. A complete list of the industries visited by the consultants can be found in annex III.

Table 1: Industries, water and sewage works and laboratories visited by the consultants

	URT	LES	BOT	ZIM	ZAM	UGA	ETH	TOTAL
Tanneries		1	2	1	1	1	2	8
Abattoirs	1	1	2		2			6
Breweries	2	1			2	1	2	8
Sugar						1		1
Textile	1	2	1		1	1	1	7
Other agro		2				1		3
Pesticide	1				1			2
Fertilizer				1	1			2
Mine/metal				4				4
Total	*5*	*7*	*5*	*6*	*8*	*5*	*5*	*41*
Water and sewage works	1	2			1	3		7
Labora-tories	3	2	1	0	2	1	3	12

TABLE 2: Industries included in the country studies and in the consultants' visits

c/s = country study; con = consultants' visits

	URT		LES		BOT		ZIM		ZAM		UGA		ETH		TOTAL	
	c/s	con	c/s	con	c/s	con	c/s	con	c/s	con	c/s	con	c/s	con	c/s	con
Tanneries/ Leather	3		1	1	2	2	-	1	2	1	1	1	8	2	17	8
Abattoirs/ Meatpack	2	1	1	1	3	2	-	-	2	2	3	-	-	-	11	6
Breweries/ Distilleries	2	2	1	1	2	-	-	-	3	2	2	1	6	2	16	8
Sugar	3	-	-	-	-	-	1	-	1	-	2	1	3	-	10	1
Textile	5	1	2	2	1	1	1	-	2	1	7	1	9	1	27	7
Subtotal	*15*	*4*	*5*	*5*	*8*	*5*	*2*	*1*	*10*	*6*	*15*	*4*	*26*	*5*	*81*	*30*
Other agro	1	-	2	2	-	-	-	-	-	-	10	1	-	-	13	3
Pesticide/ pharm.	1	1	1	-	-	-	-	-	2	1	-	-	-	-	4	2
Fertilizer	1	**	-	-	-	-	1	1	1	1	-	-	-	-	3	2
Mine/metal	-	-	-	-	-	-	3	4	-	-	-	-	-	-	3	4
Total of. industries	*18*	*5*	*8*	*7*	*8*	*5*	*6*	*6*	*13*	*8*	*25*	*5*	*26*	*5*	*104*	*41*

The United Republic of Tanzania country study also includes 14 more oil and soap industries and a number of other industries in various industrial branches and in more or less detail

** The industries visited by the consultants are in nearly all cases included in the country studies.

III. INDUSTRIAL WATER USE AND WASTEWATER CHARACTERISTICS: WASTEWATER TREATMENT AND WATER POLLUTION CONTROL

A. Water use and wastewater characteristics

15. An overview of data on production, water use and effluent characteristics drawn from the country studies and field visits is shown in table 3 for the five industrial sectors selected. For further information on the kinds of pollution to be expected from various agro-based industries, see table 4.

16. The scarcity of quantitative data is striking, and much of the data shown are of uncertain reliability. The figures presented in table 3 are meant to give an indication of water use and effluent characteristics, and to show the wide variation in the values among the participating countries. From the table it can be inferred that while production data is normally available for industry, water use data is available for only approximately half the number of industries, and reliable wastewater characteristics are generally not available.

17. The paucity of water data assembled here should not be construed as criticism of any national expert. The experts went to great lengths to assemble and present available data. However, data are scarce and unreliable because in those countries regular monitoring of industrial water use and wastewater discharge is the exception rather than the rule.

B. Wastewater treatment and pollution control

18. The pollution effects and treatment practices found in plants visited by the consultants are summarized in table 4. These findings are based on a qualitative rather than quantitative approach, due to the almost complete absence of comprehensive and reliable quantitative data. They show, among the following, that:

19. Out of thirty plants visited, twelve were discharging wastewater into a public sewer and eighteen directly into nature (water or land). Pre-treatment facilities for processing prior to discharge into sewers had been installed at eight of the twelve, but only two of these pre-treatment plants were operational. Nevertheless, considerable water pollution was found only in three out of the twelve cases. This judgment was based on the assumption that if the municipal treatment works seemed to be in reasonable working condition, then the pollution was not severe.

20. Treatment facilities for processing before discharge into nature had been installed at nine plants out of eighteen, but only two of them were in operation. Water pollution was found at fifteen of the eighteen plants discharging into nature. The only three not causing severe pollution were one tannery (BMC at Lobatse, Botswana, employing evaporation techniques), one abattoir (the National Abattoir at Maseru, Lesotho, using irrigation), and one textile facility (Shashe Silk, Botswana, using land application).

Table 3: Data on production, water use and effluent characteristics in five industrial sectors selected

		Production		Water use at present	Effluent characteristics (mg/l)				
		capacity installed	present		BOD	COD	SS	pH	Other
TANNERIES									
Basotho Tanning (Pty) Ltd	LES	NA	Not oper.	NA	NA				
BMC Tannery, Lobatse	BOT	1400 hides/d	100 %	245 m3/d	12100	17020	-	-	SO4 8976, Cl 3849, TDS 10049 ****)
Pilane Leathers (Pty) Ltd	BOT	3000 t/month	100 %		NA *)				
Inpumelele Tanning	RSA	?	700 hides/day +5000 skins/d	800 m3/d	NA				
Bata Shoe Tannery	ZAM	750 hides/d	80 %	200 m3/d	4000	4700	30028	12,5	Sulphide 60, Chrome 86, TDS 18538 **)
Uganda Leather and Tanning Ind. Ltd	UGA	630000 m2/yr	50 %	NA	660	80	-	6,5	Sulphides and Chrome present ***)
Awash Tannery	ETH	1000 t/yr	100 %	1000 m3/d	1705	3000	3424	11,94 **)	
Ethiopian Tannery	ETH	10000 hides/d	100 %	NA	NA				
ABATTOIRS									
Tanganyika Packers Ltd	TAN	65000 heads/yr	Not oper.	-	NA				
National Abattoirs (NAPC)	LES	200 heads/d	50 %	NA	NA				
BMC Francistown	BOT	500 heads/d	100 %	600 m3/d	NA				
BMC Lobatse	BOT	1400 heads/d	70 %	1640 m3/d	140				
Zambia Cold Storage Corporation	ZAM	300 heads/d	65 %	NA	1820	2710	930	7,5	TDS 412 **)
Zambia Pork Products	ZAM	250 pigs/d	?	NA	2000	3200	584	7,6	TDS 174 **)
BREWERIES									
Tanzania Breweries	TAN	250 m3/d	40 %	NA	NA				
Dar Brew Ltd	TAN	10 m3/d	?	20 m3/d	NA				
Maluti Mountain Breweries	LES	40000 m3/yr beer +4000 m3/yr softdrinks	100 %	1300 m3/d	NA				
Zambia Breweries	ZAM	80000 m3/yr	70 %	NA	256,7	845	166	7,8	TDS 760 **)
National Breweries	ZAM	110 m3/d	?	NA	320	503	84	7,6	TDS 722 **)
Uganda Breweries Ltd	UGA	125 m3/d	100 %	NA	One sampling done in 1970 only				
Mekanissa Distillery	ETH	?	6,5 m3 alcoh/d	180 m3/d	855	1495	504	4,69 **)	
Addis Ababa Brewery	ETH	18500 m3/yr	80 %	NA	NA				
SUGAR									
Sugar Corporation of Uganda	UGA	100 t/d	100 %	NA	NA				
TEXTILE									
Friendship Textile Mills Ltd	TAN	32 million m/d	50 %	NA	NA				
Lesotho Fabrics Processors (Pty) Ltd	LES	20 t/month	100 %	15 m3/d	NA				
CKH Industrial (Pty) Ltd	LES	50000 jeans/m	100 %	350 m3/d	NA				
Shoshe Silk (Pty) Ltd	BOT	10 t/d	100 %	170 m3/d	1000	7000	Occasional analysis on the dyeing wastewater only		
Kafue Textiles of Zambia	ZAM	20 t/d	60 %	NA	1600	4900	2248	9,1	TDS 1400 **)
Nyanza Textile Industries Ltd	UGA	100000 m/d	60 %	750 m3/h	NA				
Akaki Textile	ETH	700 mill ir/yr	?	1000 m3/d	675	1500	805	11,87 **)	

NA = Not Available

*) Samples on different wastewater streams have been analysed on one occasion

**) One grab sample

***) Average of a few samples

****) These values are apparently from untreated wastewater

Table 4: Pollutants from agro-based industry

Pollutants	Tanne-ry	Abat-toir	Brewe-ry	Sugar	Tex-tile	Dairy	Food proc.	Wool scour
Organic matter								
Proteins	x	x	x	x	x	x	x	x
Carbohydrates		x	x	x	x	x	x	
Fats and Oils	x	x			x	x	x	x
Dyestuffs	x				x			
Organic Acids			x	x				
Phenols					x			
Detergents		x	x		x	x		x
Organo-pesticides	x			x			x	x
Inorganic matter								
Acids	x		x		x			
Alkalis	x		x		x			
Metals					x			
Metallic salts	x							
Phosph- and nitrates		x		x		x		
Other salts	x				x	x		
Bleaches					x			
Sulphides	x				x			
Chromates	x							
Minerals (clay, soil)		x		x			x	x

NOTE: A table similar to this was included in the Lesotho country paper. Sugar industries and abattoirs have been added to the table and agriculture deleted. Minor adjustments have been made.

Table 5: Treatment and disposal of wastewater at plants visited and the environmental effect - a summary

		Tanneries	Abattoirs meatfact.	Breweries distill.	Sugar indstr.	Textile industr.	Sum
1. Discharge to publ. sewer		3	3	3		3	12
1.1 Pretreatment	Yes	3	3			2	8
	No			3		1	4
1.1.1 Functioning	Yes		1			1	2
	No	3	2			1	6
Why not	Overloaded	1					1
	Bad design	2	2			1	5
	No mainten	2	2			1	5
	Bad operat						
1.2 Munic. treatm.works	Yes	3	3	3		3	12
	No						
1.2.1 Functioning	Yes	2	3	2		2	9
	No	1		1		1	3
1.3 Water pollution	Yes	1		1		1	3
	No	2	3	2		2	9
2. Discharge to nature		5	3	5	1	4	18
2.1 Treatment works	Yes	4	3	0		2	9
	No	1		5	1	2	9
2.1.1 Functioning	Yes	1	1				2
	No	3	2			2	7
Why not	Overloaded	1	1			1	3
	Bad design	3	1			1	5
	No mainten	2	1			2	5
	Bad operat						
2.2 Discharge to Water		1½ *)	1	5	1	3	13½
Discharge to Land			2			1	3
Discharge to Evaporation		1½ *)					1½
Functioning	Yes	1	2			1	4
	No	½ *)					½
2.3 Water pollution	Yes	4	2	5	1	3	15
	No	1	1				3
Sums total		8	6	8	1	7	30

*) This ½ is the Ethiopian Tannery, where half of the flow is directed to the activated sludge treatment and half is channelled to evaporation ponds.

21. Reasons for mal- or non-functioning of pre-treatment or treatment works were: overloading (4 cases), poor design (10 cases), and lack of maintenance (10 cases). In some, more than one of the reasons was pin-pointed. In no case was the fault with the operator (if there was any). Further plant- and branch-specific information on industries visited is included in chapter IV.

22. One important observation should be noted here. Even in the major cities, industry is not a dominant source of water pollution. This is not because industrial pollution has been controlled to an acceptable level, but because there is so little industry as yet, compared with other sources of pollution such as domestic waste and silting from soil erosion.

23. At present, there is no public sewerage system in Addis Ababa and in Dar es Salaam it is only partially complete. Gaborone's sewerage system has great difficulties in keeping up with the increasing water consumption, etc. Industrial pollution should be viewed against the background also of other sources of pollution. It would clearly be a priority to introduce and strengthen public sewerage systems and allow industry to connect (after due pre-treatment) and to contribute to the costs of the common utilities.

C. Recommendations

24. Consideration should be given to ascertain whether discharge into a public sewer is possible, as this should be preferred for (pre- treated) wastewater from agro-based industries;

25. Much more attention should be paid to the design, maintenance and control of wastewater treatment works. To achieve this, the following should be established in Governments:

(a) Technical/environmental units with staff competent to assess proposed installations;

(b) pollution inspectorates to control and monitor, ensuring that works are kept operational;

(c) means to ensure that expansion of treatment works is initiated at the same time as expansion of industry.

26. Wherever possible, alternative methods of wastewater discharge, such as irrigation, land disposal and evaporation should be utilized.

27. Public sewerage systems should be established and strengthened, where needed, and agro-based industries should be allowed to be connected to them and at the same time contribute to the costs.

IV. INDUSTRIAL STATUS AND TECHNICAL OPTIONS

A. Selection of technical options

28. Whenever possible, as shown in chapter III and table 5, discharge of pre-treated wastewater from agro-based industrial plants into a public sewerage system is a very good option. This option has specifically been emphasized in the Botswana study and is also part of the Botswana guidelines for water pollution control. A similar point is implicit in the Zambian Local Administration Act.

29. A number of technical options for wastewater treatment and disposal are already in use in Botswana. For instance, the combination of an abattoir and tannery, as in the case of Botswana Meat Commission (BMC) at Lobatse, is a good example of the use of appropriate technologies for production, pollution control and wastewater treatment. The hides are fleshed in the abattoir and the meat and tissue are sent to the by-products plant, while the hides need not be cured or soaked at the tannery. Similarly, gravity flows and pond treatment of organic waste in water are solutions of choice in a country like Botswana. Land is normally available, temperatures are favorable and there is plenty of sunlight. Ponds are not very sensitive to variations of load and, although they do require some maintenance, compared with conventional treatment plants this requirement is minimal.

30. The re-use of treated wastewater for the irrigation of crops is operation at Francistown, Botswana, and is planned for Lobatse. This is an ideal solution for the final disposal of treated wastewater. However, wastewater that is allowed to enter into the sewerage system must be carefully controlled to avoid passage of chemicals that are hazardous or injurious to health or crops. This has been accomplished by keeping tannery waste separate and treating it by evaporation at the BMC tannery.

31. In the climatic conditions where rivers have seasonal flows due to irregular and/or very little precipitation, evaporation of some wastewater in ponds has been the chosen alternative to conventional dilution in a receiving water. The average evaporation rate in Botswana exceeds the average precipitation rate by some two metres per year, which provides an opportunity to dispose of considerable quantities of toxic and hazardous wastewater in a relatively limited area of land. The solids remaining from such evaporation will, if the wastewater from which they are derived contained hazardous matter, have to be handled as hazardous waste.

32. The remaining problem in Botswana seems to be to adopt the above methods in a consistent manner at an early stage of development and to monitor their performance and environmental effects.

33. Technical options to reduce water consumption and improve the wastewater quality of industries are presented below by sector. Many of the options are of a general nature and can be applied equally well to different industrial sectors. Some options are specifically dependent on regional and climatic conditions and would have to be carefully adapted to the circumstances of each country. The findings and recommendations are based on information from the country studies and other sources, as well as from field visits and meetings in each country. The industries and industrial facilities chosen are relevant to the water pollution aspects of this programme, but may not necessarily represent the situation in the whole country.

B. Abattoirs

1. Production process and waste water and solid waste generation and treatment requirements

34. Water use at an abattoir is often in the order of 1.2 m^3/head of cattle or, say, 5 - 6 m^3/tonne of animal. Water savings are generally possible throughout the plants and should be encouraged. Special self-closing valves and nozzles should be put on hoses; dry cleaning of floors and vehicles should be done before washing with water, etc. A favorable option is the combination of an abattoir and a tannery, as the fleshing of hides can be done at the abattoir: the meat goes to the by-products plant, while the hides need not be salted or soaked at the tannery.

35. The specific pollution load from an abattoir depends on the internal anti-pollution measures in use, but is normally in the order of 15 - 20 kg BOD/tonne of animals. Abattoirs should avoid water pollution by recovery of waste blood, tallow, faeces, bones, horns, hoofs, paunch contents, etc. In an abattoir with good recovery, there will be approximately 4 tons of solid organic waste per 1,000 cattle killed. Methods for flotation of tallow from the blood water and for the precipitation of proteins should be used. Organized composting rather than disposal into water should be practiced for the organic solid waste.

36. A suitably-dimensioned pond system starting with an anaerobic pond should be considered a minimum treatment standard at existing sites. In the case of new facilities or major rehabilitation of old ones, planning should ensure minimum use of water and maximum use of products and by-products as outlined above. For wastewater treatment, in addition to anaerobic ponds, bio-filter or mechanical aeration (for instance in a Pasveer ditch) should be seriously considered as an alternative to facultative oxidation ponds. Discharge into a public sewer system is a good option if there is sufficient capacity. Even in this case, however, anaerobic pre-treatment is an advantage to reduce and equalize the organic load before final treatment.

2. Present situation

37. A total of eleven abattoirs/meatpackers were included in the preliminary studies, of which six were visited by the consultants. Only one abattoir, that of BMC at Francistown, Botswana, was new, and had a combination of low water use, a functioning by-products plant and adequate wastewater treatment and disposal. At a further three abattoirs, the by-products and pollution control facilities were good. One of these, however, the National Abattoir at Maseru, was experiencing temporary difficulties due to failing blood recovery. At the remaining plants, by-products were not recovered and there was no wastewater treatment. The three abattoirs in Uganda, though, were connected to the municipal sewerage system.

3. Recommendations

38. In new abattoirs and in the rehabilitation of old ones, provisions should always be made for the full recovery of by-products such as blood, bone- and carcass-meal, tallow of different grades and, if possible, proteins present in the wastewater. Solid wastes and sludges should be composted. As a priority from both production and pollution control points of views, plants for maximum recovery of by-products, including the composting of manure and paunch contents, should be installed also at existing abattoirs.

C. Breweries

1. Production process

39 Normally, the brewing of beer begins with prepared malt, grain that has been allowed to start growing and then has been dried. In the brewing process, the malt is mixed with water and heated to approximately 78°C. Sugar, caramel and starch may be added. Hops are also added to the wort. The liquor is cooled to approximately +10°C and then yeast is added. The brewing itself takes 7-10 days. The beer is then stored for approximately three weeks; sediments are removed, then the beer is filtered through a kiselgur filter and carbon dioxide is added. Bottling and canning come last. The normal water consumption in a modern brewery is 4-5 m^3/m^3 of beer produced.

2. Waste water and solid waste generation and treatment requirements

40. At a brewery, a number of by-products should be recovered rather than wasted: spent grain and settled insolubles (proteins, etc.) can be removed and sold as by-products. Carbon dioxide produced in the fermentation process can be recovered using industrially-established equipment, and either added to the beer or used for soft-drinks. It can also be collected by the simple use of a compressor and storage tank, and used for the neutralization of the effluent. The yeast can be re-used for some 10 generations in the fermentation before being replaced by new yeast. Excess yeast should be removed, dried and sold as a by-product. It is essential to use the above means to keep down the water-flow and to avoid excessive organic pollution. This will in turn keep the cost of wastewater treatment low.

41. The quantity of wastewater from a modern brewery should not exceed 5 m^3/m^3 beer produced. If all by-products have been recovered to the extent possible, then the following specific concentrations can be expected in a brewery: 5 kg BOD, 10 - 13 kg COD, 0,03 kg P-tot, 0,2 kg N-tot, all measured per m^3 beer produced.

42. Soft-drink production adds little to the wastewater problems of a brewery. The wastewater contains the same kinds of washing liquids and spillage of the sugar-containing drinks. Carbon dioxide from the brewery can be used in the production of soft-drinks. In a modern soft-drink factory, the specific pollution load would be 1 - 2 kg BOD/m^3 of product.

43. An automatic method of cleaning tanks has been developed. It is called cleaning-in-place . With this method, the quantities of rinse-water, washing liquids and disinfectants can be better controlled. Cooling water and steam condensation should always be re-used and some of the rather clean wastewaters can be re-used for less demanding purposes such as cleaning.

44. The internal measures mentioned above to reduce water consumption and to recover by-products should always be included in a new brewery. They would increase productivity also in an existing brewery and reduce significantly the pollution load.

45. The siting of a brewery should preferably be made so that the distance to housing areas is at least 300m, in order to avoid complaints due to noise and smell. It is recommended as a first option that the wastewater be discharged into a public sewer. In a normal brewery, effluent concentration values in the order of BOD 1000 - 3000, COD 3000 - 5000 and P-tot 7 - 14 mg/l are to be expected. Even these concentrations could be accepted into a public sewer. The maximum total hourly and daily load of wastewater flow and BOD that can be accepted for discharge into a sewerage system must be determined from case to case depending on the capacities of the sewerage pipes and wastewater treatment plant.

46. To prevent fluctuations in pH and flow of the wastewater, pre-treatment in an equalization tank is required so that the discharge into a public sewer or to external treatment can be controlled. It would normally be sufficient if the tank could hold one-sixth of the daily wastewater quantity. The acid washing water from the brewery is then mixed with the basic washing water from the bottling, and pH can be kept in the range 6.5 - 10. If needed, acid or base will be added by a dosage pump to control the pH.

47. An oxidation pond system, properly designed depending on the strength and flow of the brewery waste, is a minimum external treatment standard for discharge into natural water, thereby achieving an effluent quality of at least BOD_5 50 mg/liter and suspended solids of 100 mg/liter. If sufficient land for ponds is not available, then a mechanically-aerated system should be considered.

3. Present situation

48. Breweries accounted for sixteen facilities discussed in the preliminary studies, of which eight were visited by the consultants. Of the eight visited, one was a distillery making alcohol from molasses, two were making traditional beer (kibuku) and five were making lager beer. Of the sixteen facilities, only one, the Harar Brewery in Ethiopia, had a functioning wastewater treatment plant. Six were discharging into a public sewer but had no functioning pre-treatment of wastewater.

49. The primary environmental problem found in the breweries examined is the over-use of water and the lack of recovery of by-products. This is where the most cost-effective action can be introduced to improve production and reduce pollution. In some cases, wastewater treatment will be required.

4. Recommendations

50. At all breweries for lager beer and as applicable at breweries for traditional beer, facilities for recovery of by-products such as spent grain, excess yeast, proteins and other solids should be installed. This is a priority from production and pollution control points of view, and should be accompanied by an adequate level of wastewater pre-treatment and external treatment.

D. Sugar industries

1. Production process

51. In the production process sugar cane is washed, cut and milled, and the juice is extracted in water. The juice is clarified by the addition of lime and sometimes carbon dioxide, to remove the non-sugary substances such as proteins and pectine. The juice is then dried in evaporation pans. Crystals are developed in vacuum pans and dried. In very rough figures, 10 tonnes of cane would yield approximately 1 tonne of sugar and require 20 kg of sulphur for oxidation.

2. Waste water and solid waste generation and treatment requirements

52. Water use in a modern facility should not be more than in the order of 5 m^3/tonne of sugar. If all possibilities of recycling the various flows of water are used, there will be very little wastewater to treat. Cane wash water should be recycled after screening and sedimentation. Condensates should be recycled for juice extraction.

53. The specific water pollution load before treatment is normally in the order of 20 kg BOD/tonne sugar. As a minimum treatment standard, an anaerobic pond with 3-5 days' retention time should be used. There may be a need for neutralization to obtain good anaerobic conditions. Through this treatment, the BOD of the wastewater would normally be reduced from 4,000 mg/l to 2,500 mg/l. This effluent can be treated in a public sewage treatment plant if the plant has the necessary capacity. Large sugar factories normally require their own wastewater treatment plants. After treatment in properly-designed oxidation ponds, the effluent should have a BOD load of not more than 50 mg/l. If sufficient land is not available for such ponds then mechanically-aerated treatment will be required. In many locations the wastewater can be used for the irrigation of cane fields; this is a good option to avoid water pollution.

3. Current situation

54. A total of ten sugar plants were included in the preliminary studies, of which one was visited by the consultants. That plant, the Sugar Corporation of Uganda at Lugazi, had moderate water use and good systems for water recycling, but no wastewater treatment. Of the remaining nine plants, two had wastewater treatment facilities. According to the data, the Triangle sugar plant in Zimbabwe had functioning pond systems but very high water consumption. The Zambia Sugar Co. at Ndola, a sugar refinery, discharges wastewater without pre-treatment into the public sewer. Three plants in the United Republic of Tanzania, one in Uganda and three in Ethiopia had no wastewater treatment at all and appeared to over-use water.

4. Recommendations

55. Recycling of water should be introduced at nine of the ten plants. Pre-treatment of wastewater before discharge into public sewers should be introduced at the sugar refinery, and full wastewater treatment is needed at eight plants. At new sugar plants or in the rehabilitation of old ones, all possible recycling of water should be introduced. The remaining wastewater flow should be treated as recommended above. At the existing plants with no wastewater treatment, anaerobic pre-treatment should be introduced as a first step, and effluent used for irrigation. Bagasse could be used for fuel or as fertilizer. Molasses should always be used as a product (for example for alcohol production), and sufficient storage and transport capacity should be available. Mud from washing and clarification and ashes from the incineration of bagasse should be used as fertilizer

E. Tanneries

1. Production process

56. In tanning there are three major production stages: (a) beamhouse operations; (b) tanning; and (c) finishing. The beamhouse operations are soaking, removal of meat, tissue and fats (fleshing) and the removal of hair by liming. The bating is the last part of this stage. Tanning includes pickling and tanning. Finishing includes retanning, dyeing, application of fat, and subsequently, dry finishing (coating). All stages include washing between the steps. Tanning may be vegetable, synthetic, chrome or combinations of these. By far, the most common method is chrome-tanning.

2. Waste water and solid waste generation and treatment requirements

57. Tanning is a chemically and technically complicated procedure. It has many variations and there are many possibilities of saving water and chemicals: short floats save both water and chemicals. Batch washing rather than running water wash can reduce the water consumption for washing by 80%. Recycling of water from wash and neutralization can reduce the total water consumption by 25%. Overall, it may be possible to reduce water consumption for full tanning from 30 l/kg hide to 10 l/kg hide. (One rawhide weighs approximately 16 kg and yields 24 ft^2 of leather and 5 ft^2 of split). High fixation of chrome methods can be used for the reduction of chrome waste.

58. The water consumption in a bovine hide tannery would normally be in the order of 340 l/hide to wet blue, and an additional 140 l/hide to obtain grain upper leather. These are the water consumption figures that may be reduced to 1/3 by the methods mentioned.

59. The chemicals used in tanning are mostly inorganic and water soluble. A tannery processing of 1,000 hides/day to wet blue would use approximately 7 tonnes/day of chemicals/salts. Of these, 2 tonnes consist of a chrome salt which is absorbed by the leather to a degree of 85%, depending on the tanning method employed. The remaining 5 tonnes/day of salts are in principle not removed in normal treatment works and are, therefore, discharged with the wastewater. The major constituents are common salt, lime, ammonium sulphate, sodium bisulphite, sodium sulphides, hydrochloric, formic and sulphuric acids.

3. Waste generation and treatment requirements

60. The untreated effluent quality found in a traditional tannery would be expected to be in the following order:

Parameter	kg/t raw hide	mg/l water used
BOD_5	60	1300
COD	175	3500
Suspended Solids	150	3300
Sulphide	7	160
Chrome	4,5	100

Volume of water 48 m^3/tonne rawhide

61. An absolute minimum wastewater treatment at existing tanneries would consist of screening and sedimentation of the beamhouse liquors, mixing and equalization of the flows and sufficiently-sized oxidation ponds to accommodate the load. This treatment would reduce the effluent concentrations in the above table to the order of BOD_5 400, COD 2000, SS 300, sulphide and chrome 30 (all in mg/l). Any existing treatment works should of course be maintained and kept in operation.

62. At the establishment of a new tannery or the major rehabilitation of an old one, the same anti-pollution measures as described above should be incorporated in the planning. In addition, there should be separation of beamhouse and chrome-tanning liquors and precipitation of chrome. Sulphide oxidation of the beamhouse liquors should be carried out, preferably with the use of a manganese salt as a catalyst. If chrome and sulphides have been reduced to the order of 1 and 10 mg/l, respectively, in their separate flows, then it is recommended that the tannery wastewater be discharged into a public sewer for further treatment in the municipal treatment plant. The proportion of tannery waste to domestic waste should not exceed 50:50. For direct discharge into natural water, a combination of anaerobic pond, Pasveer-ditch and maturation pond may be sufficient to meet the treatment standard.

63. Even when treated, however, tannery wastewater contains high concentrations of sodium and there may also be relatively high concentrations of stable organic compounds and chrome. These components could render the tannery wastewater unsuitable for irrigation even when mixed with domestic sewage. In arid countries with an evaporation rate considerably higher than the precipitation rate, evaporation ponds could be used for the final disposal of tannery wastewater. A new tannery should have effective sludge drying beds and means of sludge disposal to prevent groundwater pollution (the chrome precipitate is a hazardous waste). To avoid a nuisance from smell and noise, a recommended minimum distance to housing areas is 300m.

4. Current situation

64. Eighteen tanneries were included in the programme. Of these, eight were visited by the consultants. They were of varying ages and all use very conventional tanning techniques. Among problems identified were: a considerable over-use of water, no separation of wastewater streams, no recovery of waste chrome and, in nearly all cases, no functioning wastewater treatment system at all. At the Ethiopian Tannery, separation of wastewater flows and treatment had been introduced 15 years ago, but these arrangements were not in full operation. Only one tannery, that of BMC at Lobatse, Botswana, had a fully functioning system for wastewater treatment and disposal. (For further information see annex II).

65. At four of the tanneries visited, new equipment such as drums had been installed with UNIDO support. However, in carrying out rehabilitation work at these tanneries it had not been possible to fully address and implement the introduction of comprehensive pollution control measures within the scope of these projects.

66. At all 18 tanneries, internal measures are required. Moreover, at 15 of them, external treatment plants are also deemed necessary. At two plants (the Ethiopian Tannery and the Uganda Leather and Tanning Industries), the existing treatment works could be put into proper operation relatively easily. In such cases, each wastewater treatment plant would require a full-time operator.

5. Recommendations

67. In new tanneries and in the rehabilitation of old tanneries, the various wastewater flows should be kept separate. Water consumption at tanneries should be reduced, for instance by the recycling of wash waters and use of shorter floats.

68. Adequate wastewater treatment as set out above should be included in new and rehabilitated tanneries. At existing tanneries a "minimum treatment standard" should be introduced, to be determined by pollution control authorities (see chapter V).

69. At all tanneries, the chrome-containing wastewater should be recycled or treated by precipitation to remove the chrome. The chrome precipitate should be dried and treated as a hazardous waste or recycled (see further in chapter VII). Chrome precipitate from tanneries in the PTA region could be collected and sent for recovery at a facility for chrome-tanning chemicals. The technical and economic feasibility of developing this activity into a small-scale industry should be investigated further.

70. If technical assistance is given to the rehabilitation of existing tanneries, then this support should be combined with appropriate pollution control measures.

F. Textile industries

1. Production process

71. The industrial process in a textile industry depends on the kind and grade of raw materials used. The main sub-branches in textiles are based on the use of raw cotton, raw wool and petrochemical synthetic materials. In the countries participating in the programme, cotton is the most common raw material in the textile industry.

72. In a cotton textile industry the main production steps are the following: cleaning and ginning of the cotton, carding and spinning, slashing, mercerizing, washing, dyeing and rinsing. In garment production a number of steps would be added such as cutting, sewing, washing, ironing, packing.

2. Waste water and solid waste generation and treatment requirements

73. Adequate anti-pollution measures in the production are separation of flows, re-cycling of water, counter-current wash and rinse, good process-control, avoiding re-dyeing and over-use of dyes, etc. All this should be included in new factories and considered at the rehabilitation of old ones.

74. Before external treatment of wastewater is applied, there is normally a need for equalization of flow, neutralization and possibly precipitation of heavy metals such as chromium and copper. After such pre-treatment, discharge into a public sewer is recommended. Extended aeration on site is another possible solution.

76. For existing textile industries, a pond system is a minimum requirement. The efficiency of the ponds will, however, depend on factors such as the mix with other wastewaters, availability of organic matter and nutrients, and the concentration of dyes which may inhibit algal growth. A good option is to separate the finishing and dyeing wastewaters and treat this flow separately by screening, sedimentation and chemical precipitation.

77. Due to the complexity of the textile industry and the over-use of water and other bad practices at old industries, it will be very costly to introduce effective treatment of wastewater. The only rational way to approach the problem is from the process optimization side by combining processes and better selection of dyeing methods used, etc. By such methods, the wastewater flow can be reduced by 40%. Energy consumption can also be reduced in proportion. This is the only effective method to reduce treatment costs and be competitive and environment-friendly in this branch of industry.

3. Current situation

78. Of 27 textile factories included in the preliminary studies, seven were visited by the consultants. Of these, the Shashe Silk factory in Botswana had wastewater pre-treatment, and further treatment was planned. Of the remaining 26 facilities, only two seemed to have acceptable wastewater treatment facilities: the Lesotho Fabrics Processors at Maseru and D Whitehead at Triangle, Zimbabwe. Four other plants were connected to public sewers and did not appear to cause severe pollution. This leaves 20 factories causing pollution due to either missing or non-functioning wastewater treatment.

79. One problem of non-functioning treatment plants can be attributed to the use of oxidation ponds for treatment. The treatment in facultative ponds is often not successful because dyes and other toxic elements in the wastewater inhibit algal growth. Screening, chemical treatment and sedimentation may be needed before the biological treatment. Also, the performance of conventional wastewater treatment plants, such as the bio-filter at Maseru, may suffer from the discharge of untreated wastewater into the public sewerage system.

4. Recommendations

80. Most of the existing textile plants are old and apparently over-using water. Wastewater treatment will be a very expensive undertaking at such factories. It is suggested that internal measures to separate flows and to recycle water etc., should be the first priority in this industry. Furthermore, internal measures in the textile industry are required to optimize processes, promote water recycling and lower the water use. The need for and possibilities of treatment of separate wastewater streams should be decided in the modernization process. The alternative is advanced and costly pre-treatment of discharged effluent.

V. REGULATORY MEASURES FOR WATER POLLUTION CONTROL

A. Introduction

81. The essential elements of a water pollution control programme are: legislation, standards, permits, compliance monitoring, and enforcement. Legislation authorize the programme and acticulates the general objectives of the programme. The major purpose of the other four activities is to implement the programme by encouraging, guiding, or prohibiting future conduct that is inconsistant with the objectives of the programme.

82. The basic objectives of water pollution control legislation are very simple and straightforward. Although these objectives have been articulated differently by different legislatures, they can all be reduced to the same basic aim, i.e. achieving and maintaining water quality at acceptable levels. However, the whole issue of how to attain this objective is extremely complex as evidenced by the different types of legislation which has been enacted and by the very varied water pollution control programmes which have been applied.

83. A common problem facing all countries is embodied in the question: how pure should water be? All water, whether in a stream untouched by man or alternatively heavily used, can be improved in quality, but the question is to what extent is this necessary. Clearly, the most simple solution is to prohibit the discharge of pollutants into water. This solution is easy to propose but impossible to implement. Since the resources available for improving water quality are extremely limited, the water quality to be attained and the benefits to be derived therefrom are interrelated and are of increasingly great concern. The basic requirement, i.e. to achieve acceptable water quality at the least cost as well as the need for equality in the sharing of expenses, has led to a number of different approaches in the formulation of national water pollution control legislation. Concepts and mechanisms embodied in some of the more recent legislation on this subject are described below.

84. In table 6, an attempt has been made to characterize the water pollution control programmes in the participating countries. Time did not always permit a complete picture to be obtained. It should also be mentioned that in several of the countries, new water or environmental legislation is being drafted. For example new water legislation has been proposed for Botswana ,Ethiopia and Lesotho and environmental legislation is in under preparation in the United Republic of Tanzania, Zambia and Zimbabwe.

Table 6: Overview of existing regulatory measures for the discharge of wastewater in the participating countries

Country	Statutes for discharge into public sewer	Statutes for discharge to natural water	Standard conditions for pollution in act	Standards or guidelines for effluent	Provisions for: discharge permit	Provisions for: full information in applications	Provisions for: appeals	Provisions for: penalties	Monitoring carried out on a regular basis	Water quality laboratory	Enforcement of the legislation
TANZANIA	*	Water Utilities Act 1974 Amendment 1981	Yes	Temporary standards	Yes	No	Yes	Yes	No	Not adequate	No
LESOTHO	No	Water Resources Act 1978	Yes	No	No	Yes	Yes	Yes	No	Not adequate	No
BOTSWANA	Town Counc. Public Sew. Regulations 1982	Water Act 1967.	Yes	Guidelines	Yes	Yes	Yes	Yes	No	Yes	Informal
ZIMBABWE	*	Water Act 1970 + Amends. Water (Effl. and Wastew. Standards) Regulations 1977	Yes	Fixed stds for two categories Exemption possible	Yes	Yes	Yes	Yes	Mainly in natural waters	Not adequate	Informal and administrative
ZAMBIA	Local Administration Act, 1980	Water Act 1978	Yes	May be issued but have not	* Siting may be pre-assessed	*	Yes	Yes	No	Not adequate	No
UGANDA	Public Health Act 1935, Rev. 1964	Public Lands Act 1962 and 1969	Yes	No	No	*	*	*	No	Not adequate	No
ETHIOPIA	Public Health Proclamation 8/87	Proclamations 217/81 and 218/81 on Water Resources	Yes	No	No	No	*	*	No	Not adequate	No

* no information available

B. General Background

85. Two types of standards are typically involved in water pollution control regulations. The first type is water quality standards which must be met for a given indicator of water quality at a specified location. For example, a stream standard may require that dissolved oxygen, averaged over a 24-hour period at a selected rive mile point, must not fall below 4 parts per million (ppm) more than one day per year. The second type is effluent standards, which specify the mean or maximum permissible discharge of a pollutant, such as SS or BOD, from one particular source. Effluent standards are requirements (either by weight of materials or concentrations) set on the quality characteristics of actual discharges, while water quality standards refer to ambient concentrations in the receiving watercourse.

86 Water quality and effluent standards coexist in control programmes today and must be viewed as potential complements in a rational programme of management. In a situation where there are numerous waste discharges, achieving a water quality standard through several independent decisions will be impossible. Therefore, a central agency must provide information and incentives which will produce co-ordinated behaviour. Effluent standards will be meaningful only in the context of water quality goals or standards in the water course. Sometimes a combined approach of water quality and effluent standards may be used by setting individual effluent standards which reflect the size and location of the discharge relative to the waste assimilative capacity of the river stretch.

87. When setting water quality standards in developing countries, factors such as technological feasibility and cost must be considered as well as the possible effects of pollutants on human health or aquatic organisms. Such standards should minimize all the known environmental and health hazards and should be regularly reviewed in light of new knowledge. Since water quality must be considered in relation to the intended use of water, there is no unique set of standards for streams, lakes or ground water, and the problem cannot be solved in a general way. Standards for water intended for drinking will generally be higher than those for most industrial uses.

88. Water quality standards are usually issued at the national level based on the water quality goals of the country. In connection with application of effluent standards, a general discussion is found in the following paragraphs.

1. Local effluent standards

89. These are basically derived from uniform standards by the introduction of certain modifications based on local conditions. This may, for example, result in different effluent concentration levels for different river basins or sub-basins in a country. The desired water quality goals in a particular part of the receiving water can be approached in a directed and economic way. All discharges into river systems as well as flow and water use requirements have to be taken into account in this process. Thus, standards are set with the needs of one river system in mind, thereby allowing an optimal adaptation of wastewater treatment to local needs.

90. The consequences are a minimum of necessary expenditure for pollution control and inequalities in the treatment of different competing industrial sites. A major disadvantage is the need for highly skilled local river management to ensure the setting of appropriate standards. In addition, it is rather difficult to draw up legislation to implement the system because of the large number of variables involved. In the case of large international rivers, the setting of local effluent standards would be very complex and could rapidly lead to disputes between governments. In this particular case, uniform effluent standards would seem to provide the only practical solution.

91. The major disadvantage to a system of effluent standards alone is that it does not provide an incentive to the sources of pollution to treat their wastes or alter their production processes. Enforcement is generally carried out by random checks on factory effluents by government agencies, followed by fines or warnings to those plants not complying with regulations. The delinquent plant may prefer to delay compliance with standards and to engage the government in long legal battles. A charge on effluents, on the other hand, provides an immediate incentive for the plant to reduce its waste discharges. Furthermore, the administrative and enforcement expenses needed to make the system function effectively are enormous. In practice, the political and economic costs of a fully effective programme of direct regulation are simply too high for most governments to bear.

2. Mixed systems: charges and standards

92. Effluent charges may be used in conjunction with effluent standards in mixed systems which demonstrate that the two instruments are not mutually exclusive. These systems may be viewed as either regulatory programmes in which charges play an enforcement role or as bona fide charge systems in which specified discharge levels have been exempted from the charge.

93. The former German Democratic Republic and Hungary enacted water pollution control programmes which combine charges and standards. Both levied charges on all discharges in excess of fixed effluent standards. Charges in Hungary are based on costs of attaining the discharge standards, taking into account the condition of the receiving water and other factors. Revenue from the former German Democratic Republic was directed at abatement, environmental improvement measures, and compensation to some pollution victims. The Hungarian system seems to rely solely on discharge sampling by the government for its monitoring data. The charges in Hungary initially had little effect but after they were raised there was an upsurge in the installation of treatment systems.

3. Licensing of discharges

94. Based on agreed standards for the receiving water and the effluents to be discharged, and taking into account technological as well as economic conditions, systems of administrative agreement for the discharge of wastewater have been established in several countries. The following are two examples, one based on local effluent standards and the other using a uniform nationwide approach. They may serve as models for the integration of standards into a regulatory system for effective water pollution control.

95. The system of consent conditions applied in the United Kingdom of Great Britain and Northern Ireland has evolved gradually from practice, the tendency being to avoid comprehensive and rigid sets of rules. Thus, the control of sewage and industrial effluents has been achieved by considering each discharge in relation to local circumstances and imposing consent conditions. These effluent standards are, however, by no means to be regarded as uniform. Relaxed consent conditions are imposed in some cases, while in many others, where the effluent discharges to a stream from which water is extracted for supply to the public, much higher standards are set. In addition, the consents for industrial effluents include limits for the concentration of specific hazardous substances. These limits are again set taking into account river use requirements, other pollution sources, and any relevant local conditions which may be of importance when formulating the local effluent standards for the receiving water.

96. The National Pollutant Discharge Elimination System (NPDES), which was adopted in the United States of America in 1972, provides for a stringent regulatory system with precise and detailed abatement requirements, streamlined enforcement procedures, and severe penalties for violations. "Effluent Limitations" are defined as the maximum amount of a pollutant that anyone may discharge into a body of water. Municipal sewage treatment plants were required to provide a minimum of secondary treatment by 1977 and the best practical technology[1] by 1983. By the same deadlines, which have had to undergo some extension), industrial discharges will have to introduce the best practical and the best available technology[2], respectively. In addition, separate national performance standards are being issued which will set effluent limits for new industrial plants based on the best available demonstrated control technology[3].

---

[1] "Best practical technology" is defined by taking into account such factors as age of equipment, facilities involved, process employed and process changes, engineering aspects of control techniques, and environment impact apart from water quality, including energy requirements. In assessing the best practical technology, a balance is struck between total cost and effluent reduction benefits in each individual case.

[2] "Best available technology" is defined as the highest degree of technology proved to be designable for plant-scale operation, so that costs for this treatment may be much higher than for treatment by the best practical technology.

[3] "Best available demonstrated technology" is defined as those plant processes and control techniques that have demonstrated at a pilot plant level that technologically and economically justify making investments in new production facilities.

97. A zero-discharge or low-discharge approach encourages more efficient water management. An analysis of treatment costs and recycling or re-use potential has indicated that it is usually cost-effective to recycle large quantities of industrial water to reduce the volume of water that requires "best available treatment". Under the present law, it is illegal to discharge any pollutant into public waters without an NPDES permit. Types of "point" sources requiring a permit for discharges into bodies of waters include municipal wastewater treatment facilities, manufacturing plants, agriculture, forestry, mining and fishing operations, and other services, wholesale, retail and commercial establishments. Such a permit is, however, not a licence to pollute. On the contrary, it regulates what and how much may be discharged by setting specific limits on all the effluent from each source. Individual compliance schedules provide for the necessary time to install the required treatment facilities and to obtain, as far as available, government grants for their financing. Thus, a nationwide system of water pollution control has been established in the United States by combining uniform effluent standards and limitations, applied to specific sources of water pollution by individual permits, with substantial penalties for failure to comply.

98. The United States requires the issuance of a discharge licence to any polluter by a water pollution control authority, a state government or a federal agency. Penalties are imposed for violations of the agreed limits. Their distinct difference lies in the use of standards. The United Kingdom follows a highly differentiated concept of locally-determined effluent requirements, whereas in the United States a uniform pollution control approach is used which is continuously adapted to the availability of treatment technology.

99. Environmental impact assessments have not yet been widely introduced in Africa and Latin America. The importance of such analyses will become more apparent as national and international funding agencies require consideration of environmental impact as a condition to loans or grants for development projects. One international forum suggested that the pattern for evaluation of the environmental impact of a foreign investment project in a developing country ~~could be~~ adopted as follows:

(a) Natural resource linkage;
(b) Processes in the plant;
(c) Site assimilative capacity;
(d) Waste management;
(e) Operation and control;
(f) Health aspects;
(g) Social aspects;
(h) Ultimate disposal of wastes.

100. The examination of potential foreign investment must be intensified by recipient countries, international financing institutions, multinational corporations and donor countries, to make sure obsolete and dirty processes are not being introduced to developing countries. The more a firm is required to make an advance disclosure of its project and environmental control plans, the more likely it will consider in advance the potential environmental impact objections that might be raised later.

101. Many developing countries have gained good experience in preparing environmental impact statements through submitting project proposals to development assistance agencies. Although environmental considerations may increase the total cost of a project, developing countries are increasingly required to prepare impact statements in support of projects for which external financing is sought. Such statements greatly reduce the environmental uncertainty and minimize unforeseen consequences.

102. International development assistance agencies have thus provided a framework within which developing countries can learn to prepare and require of others environmental impact statements prior to the implementation of projects. International organizations, including the United Nations, should be able to provide training in the preparation of such statements. Developing countries would benefit in the long run if new industries were required to reveal their potential impact. Such a requirement should encourage them to begin with cleaner processes.

C. Legislation

1. General

103. It is not the purpose of this rather technical paper to go into the details of the legislation of each participating country for industrial licencing and planning or for water use and discharge. There is, however, a need to touch on these matters as a background for the training recommendations and for the considerations on how to control the discharge of wastewater when there are no fixed effluent standards. Reference is made to table 6. An effort has been made in the country papers and in the field to investigate the procedures for industrial licencing. It was not possible to get a complete and fair picture in each country. But, without being country-specific (there is a certain variation among the countries) the prevailing situation seems to be as follows:

(a) It is legal to issue an industrial licence without having determined the siting of a plant;

(b) it is legal to grant a plot or a site and even give a building permit for an industrial plant without having considered and determined if the industrial production technology is environmentally acceptable, which anti-pollution measures will be required, and which effluent conditions the industry will have to meet.

104. This situation has resulted in a number of industrial plants having been built on sites which were not suitable for the purpose from a pollution control point of view. It has also resulted in an unnecessary antagonistic conflict between industrial development and other interests: The anti-pollution measures required to alleviate environmental impacts have had to be more advanced and costly than they would have been if environmental aspects had been sorted out at the early planning stage. And, even with expensive treatment of waste, the impact on the environment may still be unacceptable to others.

105. In several countries, the practical situation is different. In some, committees, councils and advisory boards have been established to help avoid mistakes in development planning. Environment protection ministries and councils have also been established (for instance, in Zimbabwe, Uganda and the United Republic of Tanzania) to ensure that environmental participation and consultation is included in the planning process. This procedure of consultation should be formalized, so that a major polluting industry may not be sited or built without an environmental clearance first. A list of which industries are major polluting should be made. One such list is under preparation by the Ethiopian Valleys Development Studies Authority. But committees, however high-ranking, are not sufficient for the pre-assessment of anti-pollution measures needed and the likely environmental effects of a new industry. In addition, there is a need for a professional cadre of staff who will be able to advise and participate for the benefit of both an integrated and sustained industrial development and for a minimum of pollution and environmental impact. For control of water use and wastewater discharge, such staff should be stationed at the water resources authority in the country. But, if it has been decided that all environmental questions (air pollution, noise, waste management etc.) should be considered by one authority, then this staff could be stationed at a ministry of environmental protection or the equivalent.

106. In most of the participating countries, a water act of some sort is used for regulating water use and water pollution. Exceptions are Ethiopia, where a water act is now being drafted, and Uganda, where water apportionment is under the Public Lands Act. There is also normally a sewerage act, regulations under a township act, sections in the public health acts or the equivalent to rule the discharge of trade effluents into public sewers. In the water acts, there are normally standard conditions to the effect that: water shall be returned to the same water body as from which it was taken; it shall be substantially undiminished in quantity; it shall not be polluted to the extent that it will be likely to cause injury to other users; and precautions shall be taken to the satisfaction of the water officer to prevent injury from sewage and waste accumulation in water.

107. In some of the countries (Botswana and Zimbabwe) there are also a requirement in the water legislation to obtain a discharge permit. There are possibilities for the ruling water authority to specify conditions of treatment, effluent quality and other anti- pollution measures. The water officer may also have the right of full information before an application for a discharge permit is considered. The main problem of the water legislation, even though there are inherent limitations in the acts themselves, is not the weakness of the legislation but the fact that it has not been enforced. Government authorities

have not exercised their powers as pollution control authorities and have not put the necessary pressure on the industrialists in this respect.

2. Recommendations

108. A mandatory procedure should be formalized for conducting environmental impact assessments of major polluting industry, particularly with regard to the siting. Establish in each country a list of which industries should be considered major polluting.

109. Strong technical/environmental units should be established with professional staff in the water or environmental authorities in each country, to participate in and give advice on industrial development, water use and pollution control. Such staff should be given support by industrial and environmental training as proposed in chapter 6. The technical/environmental authorities mentioned above should be the advisory body also to the water authorities, and there should be provisions for the right of full information to form the basis for the technical work.

110. A discharge permit for the discharge of wastewater should be a requirement for major polluting industries, whether the water is obtained from a municipal water supply or from a natural body of water and whether the discharge will be to nature or into a municipal sewerage system. When issuing a water right or a discharge permit or the equivalent, the water authorities should specify in writing to the polluting industry the exact requirements for wastewater treatment and other anti-pollution measures, as well as the effluent conditions to be met. This will form the basis for the monitoring and pollution inspection work.

D. Existing legislative situation in participating countries

1. Botswana

111. The existing Water Act dates back to 1967. According to the Act, there is normally a requirement of a Water Right for water abstraction, use, discharge, etc. Procedures for application are given and regulations have been made to the Act. Water rights may be granted by the Water Apportionment Board and a register of water rights is kept by the Water Registrar. A water right may be issued under limitations of quantity, period of use, purpose and subject to such terms and conditions as the Board may deem fit. If a water right has not been used for three years, then it may be determined or diminished. Standard conditions are implied for water rights for mining, forestry, industrial purposes or for generation of power. The conditions are, in brief: water shall be returned substantially undiminished in quantity; water shall not be polluted to the extent as to make it harmful for other uses; accumulation in water courses of refuse, sewage, waste or other substances must be prevented so that reasonable use of the water is not harmed. Among other things, the Act provides for the Water Registrar the right to call for information and the right to enter upon land for inspection. The Act also provides for remedial measures to be taken by an offender, penalties and appeal. The Director of Water Affairs is the Water Registrar and he is also the Secretary to the Board.

112. Connection to a public sewer in towns can be controlled under the Public Sewer Regulations and necessary conditions may be imposed by the Minister and the Town Council.

113. The present pollution legislation (Water Act of 1967) is weak and fragmented, and is not enforced, mostly due to deficiency of adequate personnel in the various places and organizational units to which the responsibility for environmental protection (water) is being assigned. This refers to the governmental/district/local units. It should be noted that beside under-staffing, there are inadequate human and financial resources for this purpose. Consequently, the existing pollution regulations are not effectively policed and penalties for pollution offences need to be considerably stiffened.

114. The National Conservation Strategy (1989) envisages more stringent pollution legislation including revisions and extension to the Water Act and says that it should also be aimed "to protect groundwater in its natural state against pollution".

115. The Botswana National Water Master Plan (Study) and its volume II on Water Legislation, April 1990 (the draft final report of which is now under review by interested governmental bodies) is expected to endorse the urgent need for a strengthened administrative and legal framework to address pollution issues. It is also envisaged that the role of formal co-ordination of implementation of the National Water Master Plan is likely to be taken up by a national water resources council or board

charged with the implementation of the National Conservation Strategy. Either of these bodies would be well placed to ensure that pollution aspects receive the priority they deserve.

2. Ethiopia

116. The first major legislation of an administrative nature regarding inland water resources at the national level was enacted by Order 75 of 1971. Although this piece of legislation was enacted for the purpose of creating an institution at the national level for co-ordinating all activities which maybe influence the quality, quantity, distribution or use of water, etc., it also contained certain principles relevant to water resources management. These were: (a) data collection, analysis and evaluation; (b) integrated planning; (c) ensuring adequate supply of water (i.e. for domestic use, watering of animals, irrigation and other agricultural purposes, urban and industrial use, generation of hydro-electricity, transportation (navigation) and recreation; (d) control and prevention of flooding, soil erosion, and damage to watersheds, as well as protection of inland fisheries, fauna and flora and the reclamation of land; (e) ensuring the existence of adequate facilities for drainage, the safe disposal of sewage and prevention of pollution and disease; (f) ensuring the application of appropriate techniques for the investigation, use control, protection, management and administration of water, and, more importantly, (g) the preparation of national water legislation.

117. The existing legal and institutional situation with regard to water use and pollution control is complex and still not quite comprehensive. The Ethiopian Valley Development Studies Authority seems to have overall responsibilities for investigations, studies, planning, policy-making and supervision. However, the day-to-day central state administration of water resources still seems to be vested in the Water Resources Commission and more directly under it, the Water Resources Development Authority. Water supply and sewerage is the responsibility of a separate authority under the Water Resources Commission. A new water supply and sewerage authority has been established for the Addis region. Some legislation concerning sewerage appears under the Public Health Proclamation (1974).

118. The task of preparing drafting a national water law, which has also been stressed in subsequent legislation strengthening and streamlining the institutional set-up as regards the water sector, has been completed recently and a draft submitted to the Council of Ministers for enactment. The draft legislation consists of a proclamation to provide for the Ethiopian water resources code and detailed regulations for the implementation of the basic principles contained in the draft code are considered to be comprehensive as a general framework within which the water resources of Ethiopia can be effectively managed and utilized. However, further regulations specifying effluent and water quality standards, etc. are required.

3. Lesotho

119. The existing water act is from 1978. According to the Act there is a general requirement for a water use permits, except for domestic uses. Procedures for how applications should be done are incorporated in the act. According to the act, the Minister shall appoint a water officer to carry out the duties and functions in the act. A water use permit is granted by the water officer for a period not longer than five years and it can be extended for a period of maximum three years at a time. Terms and conditions necessary in the interest of the public can be included in the water use permit. The pollution or fouling of any water is an offence under the Act and it also provides for penalties and remedial measures to be taken by the offender. The water officer shall keep records of the water use permits, etc.

120. The current legislation resulting from the Water Resources Act 1978 is not enforced, mostly due to deficiency of adequate personnel in the various places and organization units to which the responsibility for environmental protection (water) is being assigned. This refers to the governmental/district/local units. In any case, there are currently no acceptable and legally binding industrial effluent discharge quality standards. Actually, there is a final draft of the "Rationalization and Consolidation of Legislation re: Water and Sewerage Management", including new management proposals and rationalization of water uses (i.e. through an apportionment committee regulation with "Abstraction and Discharge Regulations", a drafting legislation to create a water and sewerage authority, draft proposals on standards of quality of potable water regulations, and also standards of quality of effluent discharge regulations. All the proposals are aimed at consolidating, under the auspices of the Ministry of Water, Energy and Mining, the responsibility and powers for their actions in water resources management and use.

121. On the side of industrial facility developments, the Department of Industry of the Ministry of Trade and Industry, Lesotho, has recently introduced, under its "Application for industrial licence", considerations regarding water consumption and effluent discharge.

4. Uganda

122. The existing legislation relating to discharge of waste water (domestic, industrial, commercial, etc.) into public sewers, natural water courses, on land, etc. are contained in the following acts: (a) The Public Health Act of 1935/1964 Revision; (b) The Public Lands Act of 1962 and 1969; (x) the Mining Act of 1949; (d) Lands (Conveyance) Rules; and (e) The Factories Act (1964).

123. The apportionment and management of natural water is ruled under the Public Lands Act and the Department of Water Development under the Ministry of Water and Mineral Development is responsible for monitoring water quality and for pollution control. Water supply and sewerage for the seven major towns is the responsibility of the National Water and Sewerage Corporation, a parastatal under the above Ministry. The Waterworks Act covers the water supply side while the rules for sewerage are to be found in the Public Health Act. The Ministry of Environment Protection has an overall responsibility for the environmental consequences of the discharge of industrial wastewater (and other pollutants).

124. It should be stressed that the current guidelines prepared under the provisions of the National Water and Sewerage Corporation Decree (Decree 34 of 1972) for permissible levels of pollution discharged into public sewers in the towns of Mbale, Tororo, Jinja, Kampala, Entebbe and Mbarara are strictly for the use of the local sanitary authority, and have never been agreed with the Ministry of Environment Protection. The licensing of industry is regulated by the Licensing Act of 1969. The Act establishes a Licensing Board within the Ministry of Industry. The members of the Board are drawn from the Ministries of Industry, Finance, Planning, Housing, Commerce, Uganda Development Bank and the National Chamber of Commerce. The issuance of a licence to a developer is not, to date, supported by an Environmental Impact Assessment.

5. United Republic of Tanzania

125. Act No. 42 of 1974 "Water Utilization (Control and Regulation)" states the following: the abstraction or use of water - except for some specified purposes such as domestic - requires water rights granted by a water officer. The Water Act lays down procedures for the handling of applications, etc. In every water right granted for mining, forestry or industrial purposes or for the generation of power, it was implied (in brief) that: (a) it shall be returned to same water body as from which it was taken; (b) it shall be substantially undiminished in quantity; (c) it shall not be polluted to the extent that it will cause injury other users and that precautions shall be taken to the satisfaction of the water officer to prevent injury from sewage and waste accumulation in water. The current legislation is not enforced, mostly due to deficiency of adequate trained personnel in the various places and organization units to which the responsibility for environmental protection is being assigned. This refers to the governmental/regional/local units. It is noted that there are inadequate financial resources available for this purposes.

126. If a water right has not been used for three years or if the water is needed for public purposes, then the water officer can revoke or diminish the right. The Water Act also provides powers to the water officer to revoke a water permit if conditions for it have not been complied with. He also has the right to call for information for the purposes of the Act and the right of access for the inspection of works and monitoring of abstractions. Provisions are made for appeals and penalties. A Central Advisory Water Board plus Regional Advisory Water Boards were established in advisory support of the water officer.

127. Act No. 10 of 1981 of the above Water Utilization Act (Amendment 1981) makes provisions for a better control of pollution of surface water. The advisory function of the Water Boards remains as far as water utilization is concerned. The Central Water Board shall have the power:

(a) To research causes and ways of efficient prevention or control of pollution;
(b) To recommend comprehensive plans for the regulation of discharges;

(c) To formulate uniform procedures for the sampling and examination of water, sewage and industrial effluents and for the dissemination of results;
(d) To advise all organizations and persons on ways to prevent or control pollution;
(e) To recommend legislative measures for effective control of pollution;
(f) To formulate effluent and receiving water standards;
(g) To synchronize the application of water-related laws for the more effective control of pollution.

128. River Basin Water Boards may be established instead of the Regional Advisory Water Boards. The new boards are to be established in areas of water basins and, if established, the central functions are taken over by the regional water officer and Basin Board. Discharge of effluents requires a consent granted by a water officer. Facilities for treatment and sampling shall be installed and regular reports on wastes and effluents shall be returned to the water officer. The above Act (Amendment 1981) introduces also temporary standards for receiving water (three categories), for effluents (for direct discharge but also for discharge into sewage works) and moreover also for domestic water.

6. Zambia

129. The legal framework concerning the industrial wastewater management is composed of at least four relevant acts. These are: (a) the Local Administration Act, Act 15 of 1980; (b) the Public Health Act; (c) the Natural Resources Act; and (d) the Water Act of 1978.

130. A Water Development Board was established to administer the Water Law. As far as pollution control is concerned, the relevant statutory instrument clearly states the powers of the Department of Water Affairs of the Ministry of Water, Land and Natural Resources. The Water Act provides for the control of pollution arising from the disposal of wastewaters into water courses on bodies of water, although there seems to be obvious overlaps with the Local Administration Act.

131. Under the Local Administration Act, local authorities have powers to determine the conditions and standards for trade effluent and public sewage discharge. They also have powers to regulate the discharge of trade effluent into sewers. Councils have the right of access to premises for the purpose of taking samples. Moreover, the statutory instruments also provide a formula for the purpose of charging those who dispose of their trade effluent into sewers. The above Local Administration Act assigns to the local authorities the responsibilities as for the control of the generation and disposal of wastewaters is concerned. These powers appear also in the Public Health Act. The National Resources Board has been constituted under provision of the National Resources Act. This Board may make orders of the conservation of natural resources (environment protection). The general functions of the Board are, *inter alia*, general supervision of natural resources, stimulation of public interest in conservation, improvement of natural resources and general investigations, recommending legislation for conservation.

132. Despite the existence of the above-mentioned legal framework, there is, however, a lack of a workable institutional framework established for enforcement of the above legal instruments and assigned responsibilities. It does not provide for the necessary consistent mechanism for its implementation and/or is ineffective. For instance, the Department of Water Affairs has been assigned a broad legal responsibility on pollution and effluent control but it cannot efficaciously perform for extension of its obligations against the lack of national or regional water and sanitation authorities.

133. As mentioned previously, there was an obvious conflict in the responsibilities actually assigned to the Department of Water Affairs resulting from the Water Act and those assigned to local authorities according to the Local Administration Act. On the bottom line, the governmental local organizational units are more understaffed with adequate skilled personnel and the monitoring/controlling of pollution is also not performed due to lack of adequate funding and relevant equipment. The Ministry of Commerce and Industry, which is responsible for approving industry and manufacturing licences, is performing its relevant activities with the support of an Investment Coordinating Committee. The Department of Industry of the Ministry participates in consultative meetings of the Mining and Industrial Committee at the National Council for Scientific Research. There is no established co-ordinating relationship between this department and the local authorities, Departments of Water Affairs, Natural Resources, etc. Actually, industries are not required to provide Environmental Impact Assessment prior to their approval.

7. Zimbabwe

134. With regard to legal and institutional provisions for the control of water pollution control, the Water Act was first amended in 1970 to include provision relating to Water Pollution Control. Since then, various amendments have been made and incorporated into the present Water Act of 1976 (chapter 41 of 1976). The most important of these provisions are in section 101. The Act does not allow discharge into water courses of any effluent which does not meet the standards as laid down in the Water (Effluent and Waste Water Standards) Regulation 1977.

135. Water pollution control amendments which were first introduced into the Water Act in 1970 basically prohibit water pollution but allow for temporary exemptions to be granted under specific conditions.

136. As Zimbabwe lies in a semi-arid region and irrigation is needed to realize increased agricultural production, it is considered essential that the quality of effluent discharged directly into any water should be strictly controlled. Regulations have been introduced which prescribe a comparatively high standard of purity for any effluents discharged into the water and should encourage the optimum re-use of the wastewater. What should also be underlined, amongst other constituents, is that these regulations should lay down maximum permissible concentrations for cyanide, arsenic, mercury, lead and other potentially poisonous or hazardous substances that may be present in wastewater.

E. Standards and guidelines

1. General

137. One of the explanations for the non-enforcement of legislation with regard to water pollution has been that effluent standards were not available and, thereby, legislation did not have any tangible influence. There are, however, countries where standards do exist, and the standards have still not been enforced. Examples of this are the United Republic of Tanzania, where the standards are temporary, and Zimbabwe, where the standards are permanent, but exemptions can be granted. Apparently, contradicting priorities had been set. Industrial development had first priority, so pollution control had to wait.

138. Ideally, effluent standards would consist of a list of the maximum concentrations acceptable in an effluent of certain elements or parameters. This concept can be questioned. Some of the reasons are the following: there will always be other elements than those listed that need to be controlled. There should be analytical capacity available to monitor the compliance with the parameters, as that is not always the case, the concentration must be considered together with the flow to find the total load. Also, the capacity of the receiving water must be taken into account. It would simply not be reasonable to have the same effluent standards for discharge into the River Nile as for a small stream which is also the water source for a township down stream. In addition to all this, it will always happen that persons wishing to circumvent the law will drill a borehole or even take in river water to dilute the effluent to the standard before discharging.

139. Conditions for discharge must stand to reason even among industrialists. Therefore, each case of industrial development must be considered on its own merits and all relevant facts taken into account. Some of these facts are obviously the siting of the industry, the possibility to discharge into a public sewer, the possibilities in each case to treat wastewater flows according to their characteristics, to control the handling of sludge and solid waste etc. All this can only be done by competent environmental staff and in co- operation with industry. However, as an aid for the industrial planning and the work of environment protection staff, there is a need for guidelines and limitations for instance in the case of discharge of harmful industrial matter into a public sewer. The reasons for setting such guidelines are:

(a) pipes and other parts of the works may be corroded or damaged;
(b) treatment processes in the sewage works (physical, biological, chemical) may be disturbed or harmed;
(c) there may be difficulties in the sludge treatment (stabilization, de-watering etc.), and the sludge may become unsuitable for use as a fertilizer;
(d) receiving water may be polluted; and
(e) there may be risks of harm to the people working in the sewage system.

140. General guidelines for the composition of industrial discharges to public sewers should only be set for elements which may be harmful. Such parameters as flow of wastewater or the BOD load should be considered from case to case. The development and streamlining of guidelines for the permissible composition of discharge of harmful matter from industry into a public sewer should be a priority in this programme. A similar exercise could be considered for the development of stream guidelines and effluent guidelines for discharge into natural water. The effluent guidelines should be made industrial branch-specific and include the concentrations expected as results from the appropriate waste water treatment. There must always be a realistic link between effluent guidelines and treatment standards, so that one can predict what effluent quality a certain wastewater treatment can produce at a certain industry. This information will assist in the industrial planning and make it possible for the environmentalist to pre-assess the siting of a factory. The branch-specific guidelines should be developed along with the branch-specific training programmes proposed.

2. Recommendations

141. Binding effluent standards should not be adopted for industrial wastewater. Furthermore, guidelines should be established for harmful industrial waste material that may be discharged into a public sewer; for streams and lakes to be used for different purposes; and for treatment results for industrial branches (this will depend on the treatment method chosen).

F. Minimum Treatment Standards

1. General

142. A set of standards or even effluent guidelines are not very helpful in the short-term perspective in cases of pollution from existing and perhaps old and outdated industry. Most of such industries have no wastewater treatment at all, and if stringent standards were imposed, then the industry could not bear the cost. A more practical approach is appropriate. To meet exacting standards at old industry, there would normally be a need for comparatively large and expensive treatment works due to the high pollution and hydraulic loads. And even if such works were installed, then they would not be kept in operation for a very long time. At industries which are in a bad state of repair and furthermore inefficient it would as a matter of fact be more effective even from a pollution control point of view to rehabilitate the industry, put in modern technology, strengthen the management, minimize water use and make use of all possible by-products, etc.

143. At some old industries we still face the situation that the industry cannot be closed down or modernized. And it can not pay for adequate pollution control. Even this situation has to be addressed to avoid unnecessary pollution with a minimum of input. At this point enters the consultant has introduced the concept of a "minimum treatment standard". The concept has to be used with due regard to the specific circumstances in each country, and it is not a question of a universal standard. The idea is to use a robust and cheap technology that will take the brunt of the pollution load for the time being. It is possible to give an idea of what this minimum treatment standard could be in some industrial branches, and this has been done in chapter 4. However, what is possible and desirable to achieve in a given situation will still have to be considered more closely by professional staff, the pollution control authorities and inspectorates. The selection of options will depend on the sensitivity/capacity of the receiving water, availability of disused civil and mechanical works and many other factors.

2. Recommendation

144. A concept of "minimum treatment standard" should be introduced for wastewater treatment in old and outdated industry. This would not mean that industry should do nothing but that they should make a minimum-effort to check pollution. Large funds should not be used for treatment works which are old and may eventually be phased out. Available funds should rather be used to rehabilitate and modernize the industry.

G. Permits

1. General

145. Licences or permits are other important forms of direct government control which may be used in conjunction with effluent standards or charges. Licences are an essential tool for prevention of

environmental damages; for example, in Malaysia, guidelines on effluent standards are annexed to the licence. In other countries, a permit may be given to a plant using a process which is relatively safe to the environment or which discharges less than a set amount of harmful substances.

146. Effluent permits may be preferable to charges in certain situations, such as when waste discharges have historically had a right to discharge material into a river and there is no desire to take this right away from them. The permit would allow an industry to discharge a specified amount. If the main goal is to improve the quality of a stream quickly, then it might be wiser to begin by granting effluent permits rather than impose charges. Effluent permits could be granted to industries for a given period, say, five years. After that, charges could gradually be introduced. Finally, where adverse external effects are too large, neither standards nor permits would be sufficient to restrain polluters. Prohibitions would then be the only instrument available to the Government to eliminate the hazardous waste.

2. Recommendations

147. Effluent permits should be issued for all major industrial dischargers, both those which discharge directly into streams and those which indirectly discharge through municipal treatment systems. They should tailor effluent standards to individual facilities and their environmental circumstances. They should contain daily and monthly discharge limitations.

H. Monitoring

1. General

148. Any system of charges, standards or impact assessment presupposes the existence of a system for monitoring changes in effluent or stream conditions periodically or continuously. Monitoring and information-gathering are essential elements in any pollution-control system and should be given priority by governments of developing countries. Obviously, there is no single measure of water pollution. Whether a substance discharged into a waterway "pollutes" it depends on a number of factors, including the way in which the waterway is used, the location of the discharge and the time of day or year. Keeping those factors in mind, parameters must be selected to measure pollution, based on harmfulness to human health, among others. Under an effluent charge system, it is also necessary to identify the party responsible for payment of the charge. Finally, an acceptably accurate and reliable means of measuring the selected parameters over time must be chosen.

2. Monitoring compliance

149. A monitoring system for industrial wastewater discharge should start from a point where the acceptable level of discharge has been determined, in a standard condition, in a regulation or as a defined condition in a discharge permit. This should then be followed up by inspections, sampling, laboratory analysis, interpretation of data, dissemination of data and feedback to the discharging industry in the form of acceptive or corrective action. It should also include the building up of data-bases of information to make it possible to identify trends and to formulate new policies.

150. In the participating countries, pollution control inspectors and trade effluent inspectors are generally missing. Zimbabwe is the main exception from this general rule. In this country there are four persons working with pollution control monitoring and there are trade effluent inspectors in the cities. Botswana has also a pollution control unit with a few persons available. But, as a whole, the pollution control inspectorates are totally inadequate in all of the project countries.

151. It is important to note the almost total lack of quantitative data on effluent characteristics from industries included in this programme. In several country studies efforts have been made to actually present some data and a few samples were taken and analysed. In other countries, data were available from occasional sampling of effluents. The methods for sampling, analysis and reporting can, however, be questioned. (See chapter III & table 3.) In no country has a regular system of effluent monitoring been in use. The situation is similar when it comes to monitoring of the effect in the receiving water, with the exception Zimbabwe, where a country-wide water quality network has been established.

3. Recommendations

152. The countries should strengthen or establish pollution control inspectorates for the control of discharge of effluents into natural waters and trade effluent inspectorates for a similar control in municipal sewerage systems. Country-wide water quality networks and data bases should be established for the monitoring of the quality of natural waters. The activities of the inspectorates should be supported by an initial inventory of major sources of pollution and their magnitude, and a data base system should be developed to handle the information.

I. Laboratory Facilities in Industry

1. General

153. Laboratory facilities for water quality and pollution control analysis are generally not available in the industry except in a few cases. BMC at Lobatse and Ethiopian Tanneries are exceptions to the rule. At many industries, however, there are staff available who with some additional training could do the analysis, and there are several laboratories for industrially related analysis which with some additional equipment would be able to carry out their own effluent monitoring. At major polluting industries this monitoring should be regarded as a natural part of the control of the industry, including control of the industrial processes. It would also be a rational solution to let industrial staff, who are already on site and who know the materials and processes in operation, to retain day-to-day control also of the effluent treatment and wastewater discharge. Pollution control or trade effluent inspectors should only do spot checks and inspect the records kept by industry.

2. Recommendations

154. Major polluting industries should be made responsible for their own day-to-day monitoring of effluent treatment and discharge and records should be kept for inspections. Upgrading of industrial laboratories and supplementary training for laboratory staff should be provided or, as an alternative, the analytical work should be done at the central water quality and pollution control laboratory.

J Institutional Laboratory Facilities

1. General

155. The institutional laboratory facilities in each country were reviewed and inspected to the extent that time permitted. Interest focused on those laboratories where analysis of water quality and pollution control parameters are of primary concern. There are several others; for instance, in geological and university departments there are twenty-six standardization institutions or government chemical laboratories which are fully capable of doing water analysis, but where the main duties are in other fields. Such laboratories could be used for special and occasional analysis. However, for the regular day-to-day analysis of water and wastewater, our attention should be centred on laboratories servicing water resources departments, national water and sewerage departments or environmental departments. With this selection in mind, the existing water quality and pollution control laboratories found to be of particular interest to this programme were the following:

Botswana:	Department of Water Affairs' laboratory
Ethiopia:	The Water Resources Development Authority Central Laboratory
Lesotho:	Department of Water Affairs' laboratory, Water Supply and Sewerage Branch laboratory
Tanzania:	The Maji/Ubungo laboratory (Ministry of Water, Energy and Minerals)
Uganda:	National Water and Sewerage Corporation laboratory at Kirinya
Zambia:	Water and Sewerage Company laboratory
Zimbabwe:	Not available in water resources or environment departments: in central state administration oniy at the Government Analyst Laboratory.

155. All these laboratories can carry out basic water analysis and have competent staff. But overall, there is a general lack of buildings, equipment, reagents, staff and the capacity to take on an increasing number of samples and analyses on a routine basis. One laboratory in each country should be established or upgraded to be the referral laboratory for water quality and pollution control analysis. These laboratories should be under the jurisdiction of a national water authority responsible for monitoring and control of water use, wastewater discharge or for environment protection. It would also be advisable to build on the existing water laboratories.

2. Recommendations

157. The conclusion is then that a new laboratory is needed at the Department of Water Resources in Zimbabwe, and that the other laboratories in the above list should be supported (in Lesotho, Department of Water Affairs Laboratory). Laboratories would benefit from the development of appropriate standard methods for the analyses and recommendations on a model laboratory set-up. In addition, a data-base system for calculation and handling of analytical results should be developed and made available to the laboratories.

158. A model for a regional water quality and pollution control laboratory and appropriate standard methods should be adopted for the benefit of standardization among the participating countries. In addition, a data-base system for the calculation and handling of analytical results should be developed and made available. Moreover, one laboratory in each participating country should be established or upgraded to be the referral laboratory for water quality and pollution control analysis.

K. Enforcement

1. General

159. Enforcement activities are necessary to prevent violations of environmental operating permits. Traditional enforcement sanctions fall into four general categories: (informal, administrative, civil and criminal). A variety of informal responses, such as warning letters and phone calls, fall at one end of enforcement spectrum. Beyond these informal responses, environmental agencies can use administrative, civil and criminal remedies and sanctions.

160. This phase of the project did not systematically investigate the enforcement activities of the seven participating countries. The general impression from the country papers and field investigations is that enforcement activities are informal or non-existent.

2. Recommendations

161. Potential enforcement activities permitted under the existing water pollution legislation should be clarified and made available to those plants holding discharge permits. Where necessary and possible, enforcement actions should be added in order that environmental authorities have available the full range of enforcement actions. In addition, environmental authorities should maintain clear records of plants that are violating their discharge norms and the enforcement actions taken to bring them into compliance.

VI. TRAINING AND PILOT PROJECTS ON METHODS/FACILITIES

A. Training needs

1. Identification of needs

162. The following major needs for training and enhanced awareness have been identified in the programme:

(a) Promotion of public awareness of the need for environmental and health protection. This is rather a task for UNEP and the relevant counterpart ministries in the countries. Support could be provided by supplying equipment and educational material directly related to countries and regions.

(b) More staff with education in environment engineering is required in governments. Education in environment engineering could be provided at some of the universities in the region, for instance at Dar es Salaam and Lusaka, or overseas. This is a need that should be addressed by the ministries of higher education.

(c) Professional staff in water and environment authorities, as well as in industry, need an integrated education in industrial processes and pollution control, and it seems that this education should be branch-specific. This kind of education will enhance awareness and promote industrial productivity and pollution control in combination.

(d) Considering the present lack of monitoring of water quality and water pollution, there is a need for training of much more staff for inspectorate work, laboratory analysis and computer aided data handling. This training should partly be conventional and carried out at polytechnics etc., but could also form part of the training at the pilot projects outlined in this programme.

(e) Operators of wastewater treatment plants need formal training in the theory of plant operation, sampling of effluents, monitoring of plant performance, maintenance of mechanical equipment such as screens, scrapers and pumps etc. These courses can be organized through the Water Training programme mentioned below or the equivalent. The industrial wastewater treatment plants in the region need to be developed and rehabilitated in parallel with the training.

163. The emphasis of the training should be put on (c) above. As a second priority the training need under (d) should be addressed, partly as conventional training at existing schools, partly in parallel to the activities under (c). The training needs under (a) and (b) should be filled outside of this programme and the needs for training under (e) can easily be filled as mentioned above in pace with an increasing demand.

2. Recommendations

164. Branch-specific industrial packages for education should be produced under this programme during a possible later phase to provide for the teaching materials needed. The materials should include complete production descriptions with raw materials, processes, water use, sources of pollution, possibilities of recycling, wastewater treatment and disposal, control programmes etc.

165. Training should be provided for technical and industrial staff and be based on the above-mentioned industrial packages. It should be combined with actual case studies which could be prepared at the national level in co-operation with UNIDO. Industrial branch-organizations should also have the opportunity to participate and contribute.

166. Staff to be trained in the courses should be middle management professional staff with a good basic education and who are in need of experience in industrial pollution control. They should be selected from water and environmental authorities as well as from industry.

B. Training opportunity 1

167. The Ethiopian Government has established the Institute of Water Technology at Arba Minch. Administratively, the institute is under the umbrella of the Water Resources Commission and

academically it is under the Commission for Higher Education in Ethiopia. The school was established in 1987 and there is now training of water technicians and engineers mainly in the fields of sanitary engineering, hydrology and irrigation. From time to time there are also courses for lower levels of technicians such as pump and treatment plant operators, laboratory technicians etc.

168. The Institute appears to be well-suited to train various kinds of staff of interest to this UNIDO programme. It may be possible to add special courses of environmental interest such as sampling and monitoring of water and effluents and/or general environmental awareness courses. The framework of the Water Technology Institute could be used for the organization of some of these courses, and they could in Ethiopia cover for instance the tanneries and textile industries, branches of industries which are represented in the country and where good demonstration plants/facilities may be available.

C. Training opportunity 2

169. Under the auspices of the Ugandan National Water and Sewerage Corporation there is a water training school at Kampala. At this school courses are held on all aspects of operation and maintenance of water and sewerage works. The training school was started in 1984 by sending selected staff to the United Kingdom for training at Water Training International. After the training period the staff returned together with a United Kingdom project manager. The school is now used also in the World Bank-funded Uganda Seven Towns Water Project. A new building for the school will be erected near the Gaba pumping station at Kampala. The school appears to be well established and would be willing to undertake training also in the fields of industrial wastewater treatment methods/facilities.

170. The school reciprocates on the water training in United Kingdom and there are also extra programmes on pollution control and trade effluent control available. As a complement to this system of training, there is also the Eastern and Southern Africa Management Institute with management courses in the fields of industry, health, non-governmental organizations etc. The framework of the water training school could be used for the organisation of branch specific courses, and they could take place in any of the countries where the actual branch of industry is represented and where good demonstration plants/facilities are available.

D. Pilot plants/projects

171. One of the objectives of the project was to consider possible pilot plants/projects which could serve as a basis for education and training. It was determined that a separate pilot plant for training purposes only would be ineffective and uneconomic. Such arrangements would in many cases not give any immediate environmental benefit and would probably be left idle most of the time. However, as outlined below, there are cases when pilot plants will be appropriate and meet an identified need.

172. Another (in many cases better) solution would be to select real industrial projects, where environment action can be taken - or has already been taken - and strongly support those plants/projects. Then they will produce a good environmental output and realistically serve the needs for demonstration and training. And the need for the plants will be permanent. This proposal should be seen in combination with the industrial/ environmental packages proposed under training above and the proposed development of standard laboratory facilities and methods, as well as the proposed units for handling of waste.

173. The projects briefly outlined below will, of course, have to be worked out in detail. They should be seen as examples. The projects would require approval, support and co-operation by the industries and authorities involved. In these projects, there is a general need for additional anti-pollution measures, of upgrading or establishing of laboratory facilities, of establishing complete chemical and water balances, etc., at the industries in question. The national experts should be involved in the setting up of the training activities.

174. It should be noted that at present no proposal has been made for a pilot project for breweries. A proposal can be put in as soon as a brewery has developed the necessary recovery of by-products, pre-treatment of wastewater and appropriate disposal which is not now present. The Maluti Mountain Brewery at Maseru is now thinking on those lines, and if its industrial pond system could be upgraded, then this could form another project for training of professional staff.

E. Recommended pilot projects

175. The following four pilot projects are recommended:

(a) A training and pilot project on tanning processes to full skin/leather, chrome and vegetable tanning. Training will place particular emphasis on to separation of tanning, sulphide and weak wastewaters, minimization of water use, and precipitation of chrome in tannery waste. It will also include the training on a biological (activated sludge) wastewater treatment plant. The basis for this training project should be the Ethiopian tannery at Edjersa-Mojo. Laboratory facilities are available but need upgrading. Analytical and monitoring techniques can be demonstrated (see annex I);

(b) Training and pilot project on industrial processes, water use and pollution control in a combination of abattoirs and tanneries of BMC in Botswana. Combined also with demonstration of evaporation ponds and training on anaerobic and bio-filter treatment plant, flotation of composting project and possibly demonstration of the recycling of treated effluents. Laboratory and monitoring techniques can be included (see annex I);

(c) Training programme on making an inventory and setting up a data base on the industries discharging into a public sewerage system. Formulation of guidelines and trade effluent agreements. A model project can be made in Gaborone, Botswana, where this kind of activity is underway. It is also possible to locate this kind of project in other major towns. This can be combined with training projects on the monitoring and control of industrial discharges into a public sewerage system and trade effluent inspections. Laboratory facilities are available but need support. Training should include the interpretation and dissemination of results and the follow-up action needed;

(d) Training project at the Sugar Corporation of Uganda at Lugazi on sugar industrial processes, recycling of water and treatment of wastewater. The project can demonstrate recycling of various condensates and cane wash water as well as treatment of raw water for the industrial processes. There is also a distillery which may be included in the project. The use of bagasse for fuel and proper storage of molasses awaiting transport and distillation can be demonstrated. The project can easily be combined with the activities of the Water Training School at Kampala and the adjacent water laboratory. A wastewater treatment plant for the effluent should be installed.

VII. INNOCUOUS AND HAZARDOUS WASTE

176. The production of solid waste also poses a threat of water pollution at all the industrial plants under review: organic matter from abattoirs; sludges from the treatment processes - some hazardous and some not; by-products such as offal not recovered from fish processing factories; spent grain at breweries, etc. There is an obvious need to focus attention also on this side of industrial activity to avoid water pollution.

177. The first issue is, of course, to avoid waste at all. Having said that, the next issue is to separate hazardous waste from innocuous waste. This should be determined and supervised by competent staff.

A. Organic waste

1. General

178. Organic, non-hazardous waste is very common in agro-based industries. Dung and paunch contents and other solids from abattoirs are good examples. To avoid water pollution from this material, there is a need to organize composting units. Such units should also be able to receive selected organic matter from municipal waste. If well designed and operated, such composting units in a tropical country should be able to produce good manure in a few months. The composting unit should preferably be located at a wastewater treatment plant, so that the treated effluent can be used for keeping the compost moist and so that the same staff can be used. The design and operation of the composting units will, of course, have to meet all the relevant criteria for composting, such as sorting of waste, temperature, aeration moisture, nutrients, inoculation of micro-organisms if required, etc.

2. Recommendations

179. The design and development of composting units for organic, non-hazardous waste from industries should be supported. It is recommended that a pilot plant should be developed at the BMC abattoir at Lobatse, Botswana, as part of a training programme.

B. Hazardous waste

1. General

180. The issue of proper management of hazardous waste and chemicals has appeared in discussions and visits. Wastes mentioned included waste oil, chromium waste from tanneries, waste dyes from textile industries, and pesticide waste. It has also been noted that there is a need to separate the hazardous waste from the more harmless.

181. As pollution control and awareness improve, there will be an increase in the quantities of hazardous matter to be taken care of, as the waste will no longer be discharged into the environment. It may not be a question of larger quantities, but even a very small quantity of a toxic matter can poison great quantities of soil or water. It is the very purpose of pollution control to keep this matter confined instead of discharging it into the environment.

182. The proper handling of hazardous waste at industries and other places is very important and the authorities should find generally acceptable solutions to avoid risks to health and the environment. There is a need in each country for an authority to be responsible for the handling of hazardous waste. That authority should be headed by an experienced chemist and have well-trained staff. There is also a need in each country for a well-sited and designed treatment plant for hazardous waste where classification, treatment, storage and final disposal can take place as appropriate, depending on the nature of the waste. Among other things, the plant would comprise storage facilities, so that hazardous matter can be kept secure, under roof and on sealed ground. There should also be facilities for sealed dumping in ponds and drainage floors for oil-contaminated soils. Incineration of hazardous organic waste such as (PCB) is not recommended. Such incineration would have to be kept under very strict control to be effective - if not, then the hazardous material is effectively spread further.

183. The transport of hazardous chemicals and waste should be carried out with great care and responsibility. This is partly to avoid spillage and pollution along the way of transport, but also to protect transport staff and to make sure that the hazardous material is delivered at the right station. The authority for handling of hazardous waste should take responsibility also for controlling the transportation of the waste. Initially, the activities of such waste management should be free of charge. Otherwise hazardous material would be dumped rather than collected. As an alternative, industries could be charged on a flat rate per year for these services if it has proved that they produce hazardous wastes.

2. Principles

184. For assessing the risks of hazardous wastes one should first consider the following general principles (UNEP, Governing Council decision 14/30 of 17 June 1987):

(a) States should take such steps as are necessary, whether by legislation or otherwise, to ensure the protection of health and the environment from damage arising from the generation and management of hazardous wastes. To this end, states should, inter alia, ensure that transboundary movements of hazardous wastes are kept to the minimum compatible with the efficient and environmentally sound management of such wastes;

(b) States should take all practical steps to ensure that the management of hazardous wastes is conducted in accordance with international law applicable in matters of environmental protection.

185. To avoid hazards and risks with hazardous chemicals, the following statements concerning the planning of hazardous waste control are clear and have been proven:

(a) Hazardous waste should be kept separate from other wastes where it is necessary to do so for environmentally sound management reasons;
(b) Hazardous waste should be collected separately including those which are generated in small quantities;
(c) In generating hazardous wastes, appropriate arrangements for the disposal of most wastes in an environmentally sound manner should be made;
(d) In case of the management of hazardous wastes, best practical means in all aspects should be promoted;
(e) Hazardous waste should be stored, treated and disposed of at places of an approved site and facilities;
(f) The approval for a site for the disposal of hazardous should only be given after an environmental assessment has been made.

186. To avoid hazards and risks with hazardous chemicals, the following statements concerning monitoring safety and transport of hazardous waste are clear and have been proven:

(a) With the establishment of sites or facilities for hazardous wastes, the potential effects on health and the environment have to be monitored;
(b) Remedial action has to be taken in case adverse effects are discovered;
(c) Employees should be informed and controlled regularly and information on safety precautions has to be given;
(d) Transport of hazardous wastes has to be in a manner compatible with international conventions;
(e) To ensure that hazardous wastes are safely transported for disposal, records of the transport and disposal have to be maintained;
(f) In case of transboundary movements of hazardous waste full information should be presented sufficiently in advance to enable authorized persons to assess the proposed movement properly.

3. Recommendations

187. Hazardous waste management should be organized by governments, and support in the design of a model unit could be given by UNIDO/UNEP.

C. Chrome waste from tanneries

1. General

188. Chrome waste from tanneries is a serious environmental problem that has not been addressed at all in the participating countries. In the best of cases, the chrome-containing liquors are pumped to evaporation ponds and left to dry.

189. An ordinary tannery for 1,000 hides per day uses some 2 tonnes of chrome-compound per day. Approximately 10-15 per cent of this is not absorbed in the hides and results in a discharge of 200 kg of chrome per day. This can be avoided by the separation of the tannery wastewater streams and the precipitation and drying of waste chrome from the tanning flow as recommended above. The chrome should ideally be recycled, and it may be possible to do that as a small-scale industry. An argument for the organized recovery of waste chrome is also economic: The chrome compound is expensive and its procurement uses up foreign currency.

2. Recommendation

190. It is suggested that the technical and economic feasibility of collecting the chrome precipitate from all tanneries in the PTA region be examined. The possibility of developing a small-scale industry for recovery of chrome-tanning chemicals should be investigated.

VIII. SUMMARY OF RECOMMENDATIONS

191. Following are a list of the 14 major recommendations stemming from phase 1 of the programme:

1. Public sewerage system should be established/strengthened to allow agro-based industry to discharge pre-treated wastewater. Alternative discharge options such as irrigation and evaporation should be considered if applicable. When discharging to public sewers, the industry should contribute to the establishment/operating cost of the treatment plant.

2. In new tanneries and at rehabilitation of old tanneries, the various wastewater flows should be kept separate. To reduce water consumption, for instance, wastewaters should be recycled and shorter floats used. Wastewater treatment as outlined in chapter IV, and the concept of "minimum treatment standard" as presented in chapter V should be introduced. Chrome-containing wastewater should be recycled and/or the chrome should be precipitated. The precipitate should be dried and recycled or treated as hazardous waste. Chrome precipitate should be collected and sent for recovery at an industry for chrome-tanning chemicals. The technical and economic feasibility of developing a small-scale industry for this purpose should be investigated.

3. In abattoirs installations should be made for full recovery of by-products such as bone and carcass-meal, tallow of different grades and if possible proteins in wastewater. Solid wastes (manure and paunch contents) and sludges should be composted. Treatment of wastewater as outlined in chapter IV should be installed.

4. At all breweries for lager beer and as applicable at breweries for traditional beer, plants for recovery of by-products such as spent grain, excess yeast, proteins and other solids should be installed. An adequate level of wastewater pre-treatment and external treatment should be introduced in breweries as outlined in chapter IV.

5. At new sugar plants or the rehabilitation of old plants, introduce all possible recycling of water, and then treat the remaining wastewater flow as recommended in chapter IV. At the existing plants with no wastewater treatment, as a first step, introduce anaerobic pre-treatment and use the effluent for irrigation.

6. Internal measures in the textile industry to optimize processes, promote water recycling and lower the water use should be the first priority. The need for and possibilities of treatment of separate wastewater streams should be decided in the modernization process. The alternative today is advanced and costly pre-treatment.

7. The countries should strengthen or establish pollution control inspectorates for the control of discharge of effluents into natural waters and trade effluent inspectorates for a similar control in municipal sewerage systems. The activities of the inspectorates should be supported by a initial inventory of major sources of pollution and their magnitude, and a data base system should be developed for handling of information (see annex I). The inspectorates should be placed in the water or environmental authorities in each country, and would also give advice on industrial development and water use.

8. Major polluting industries should be made responsible for their own day-to-day monitoring of effluent treatment and discharge, and records should be kept for inspection. Country-wide water quality networks and data bases should be established for monitoring the quality of natural waters.

9. Laboratories in industries should be upgraded and supplementary training of staff provided. Alternatively, the analytical work could be done at a central water quality and pollution control laboratory, to be established in each country and to serve as a referral laboratory for analysis. For the benefit of standardization among the countries, a model for a regional water quality and pollution control laboratory should be adopted. For handling of analytical results a data base should be developed on country level.

10. For industrial wastewater, binding effluent standards should be avoided, and instead guidelines regulating the following should be established:

(a) Harmful substances discharged into public sewers;
(b) Recipients to be used for different purposes;
(c) Treatment results for different treatment methods (by industrial sector).

In particular the concept of "Minimum Treatment Standards" should be introduced to be applied to old industries.

11. Independent of the water supply source and whether the discharge is directed to a sewer or natural recipient, a discharge permit should be required for major polluting industries. The permit should contain specified requirements of wastewater treatment and effluent conditions to be met.

12. A mandatory procedure for environmental pre-assessment of polluting industry should be formalized.

13. When international assistance is given to rehabilitation of industry, appropriate anti-pollution measures should be included.

14. Middle management staff from authorities (water and environmental) in need of knowledge of pollution control should be trained in industrial processes, water use, recycling possibilities, wastewater treatment and disposal, etc. This should include sector-specific training packages, also containing case studies prepared on national levels.

192. A suggestion on a tannery training project is presented in annex I. Different tanning processes could be included, as well as wastewater and chrome treatment. The training would be held at the Ethiopian tannery where laboratory facilities are available, and analytical and monitoring techniques would be demonstrated.

193. A second possibility would be to hold a training project at BMC in Botswana, where both suitable tannery and abattoir plants can be used for demonstration. The wastewater treatment to be demonstrated would include evaporation ponds, bio-filter, flotation, and possibility of including composting and recycling of treated effluents.

194. A third possible training project could be the setting-up of data bases on industries discharging into public sewers, including formulation of guidelines and trade effluent agreements. Since this currently is under elaboration in Botswana, Gaborone could be the site for a model project. Included would be issues such as monitoring and control of industrial discharges together with interpretation of results from analysis made.

195. A further possibility is to hold a training project at the Sugar Corporation of Uganda on industrial sugar processes, recycling of wastes and treatment of wastewater. The project can demonstrate the use of bagasse for fuel, storage of molasses and a combination with activities at the Water Training School could be made.

Annex I

PROJECT CONCEPTS AND PROJECT OPPORTUNITIES

Project Conept A

Title: Training of Government Staff in Industrial Pollution Control

Background: As presented in the national studies prepared for this programme, an urgent need has been identified for personnel in ministries to be trained in pollution control. This need was confirmed by the UNIDO consultants. At present, there is inadequate enforcement of existing water legislation, due at least in part to a lack of knowledgeable personnel. As illustrated in the report, inclusion of this type of training in a second phase of the programme would be appropriate. The target group would be those staff working in ministries/departments in each country responsible for industrial establishments, as well as personnel responsible for environmental protection, industrial discharge and/or pollution control. Persons eligible for training should have as a pre-requisite a background in engineering.

Objective: To increase the capacity of the national authorities responsible for pollution control to fulfill their duties in regulating industrial water use and wastewater discharge according to established standards for water quality. Assistance will include strengthening their ability to monitor and control the type and quantity of water pollution anticipated, so as to minimize the negative environmental impact associated with industrial development.

Output: Twenty-eight officers from government authorities trained in pollution monitoring and control who can identify and initiate necessary actions regarding existing and projected industrial facilities to ensure compliance with established standards for water quality.

Activities: A four-week training course will be held at a suitable institute in one of the participating countries. Four persons from each country will be trained.

The course will include the following issues:

(a) Industrial production processes with presentation of options for re-use/recycling of water and raw materials. Four priority sectors will be selected, probably including tanneries and the textile industry. Field visits to relevant industrial facilities will be included.

(b) Wastewater treatment technologies with presentation of methods suitable for treatment of discharges from the identified subsectors, as well as management of the residues. Field visits will be included.

(c) Establishment of control programmes and sampling and monitoring of discharges.

(d) Case studies for theoretical/practical application of the information presented.

Project site: Two existing sites have been identified. Both include industrial plants with modern wastewater treatment processes. Some preparation would be necessary, after which training programmes could be implemented as outlined above. Other sites might also be identified, and the two suggestions should be regarded as proposals, not as final decisions.

Project Opportunity (A 1)

Title: Training of Governmental staff in industrial pollution control with focus on tannery wastewater treatment

Background: The Ethiopian Tannery (erected 1975) has a production of 1,200 hides and 10,000 skins per day. Ten per cent of the hides are vegetable-tanned and the rest chrome-tanned. The water consumption is in the order of 2,100 m3/d of which approximately half is treated in a wastewater treatment plant before discharge back into the Koka Dam Lake. The other half is channelled to evaporation lagoons. The water source for the tannery is the lake, and the raw water is treated by aluminium sulphate coagulation, precipitation and sand filtration

The tannery has been designed so that three different kinds of wastewater streams can be kept separate: (a) tannery wastewater; (b) sulphide/lime wastewater; and (c) weak washing and neutralization wastewaters. The tannery wastewater is channelled to two evaporation ponds, and the sulphide/lime wastewater is channelled to two other evaporation ponds. The weaker wastewaters are pumped to an activated sludge wastewater treatment plant.

The tannery has a laboratory, but it can at present not carry out wastewater analysis due to lack of some equipment and reagents. Competent staff is availabie.

This tannery would provide an excellent basis for training. It has the combination of a large, well-functioning tannery, separation and adequate treatment of different wastewater flows, precipitation of chrome and reuse of washwaters, evaporation ponds, and the access to laboratory resources. Complete and detailed information could be gathered on the industrial processes, use of water and chemicals, flow diagrams and balances, design data on the wastewater treatment plant etc. It is recommended that under the second phase of this programme, training packages be developed for teaching a combination of tanning processes, wastewater treatment, laboratory and monitoring methods at the Ethiopian Tannery. Technical/environmental staff from both water and environmental authorities and from industry could participate to exchange experience and enhance awareness. Development of the training project would be done in co-operation with the national expertise in tanning and industrial water pollution control.

It is proposed that some 20 professional staff be trained for a period of four weeks each. The training should be partly formal, partly practical and include the various aspects of operating and monitoring the tanning and wastewater treatment. It would be an advantage if courses for lower technical staff could be held at the same time as courses for the professional staff. The work of the technicians could then be integrated in the higher training so that monitoring (sampling and analytical) work can be carried out and so that those taking the less technical courses can get interpretation and feedback from their monitoring work.

Pre-requisites: Prior to conducting training at the Ethiopian Tannery, however, there are a number of proposed actions to rehabilitate the tannery with regard to interral pollution control measures and external wastewater treatment:

Needs and problem areas

In the beamhouse, the valves to be used for separating wash waters from strong sulphide water are not working. Consequently, the streams are mixed and too strong a waste-flow is taken to the treatment plant and too great a flow is channelled to the sulphide/lime evaporation ponds. These ponds are now overflowing into the lake.

The tanning wastewater is kept separate from other flows. But, since only one of two lagoons is in operation (one is waiting for cleaning), also this very strong and chrome-containing wastewater is now overflowing into the lake. Both ponds must be put into operation.

The treatment works for the weak wastewater is not in full operation: It appeared as if the sludge age and sludge load is not satisfactory.The equipment for control of pH and dosage of

chemicals for flocculation had been removed. One aerator was not in operation and the mixing was not in use. The flow meter at the discharge channel was out of operation.

The operation of the treatment works and the discharge of wastewater is not monitored and the laboratory is not functioning with regard to water quality and pollution control analysis.

Rehabilitation action recommended

Reduce the water consumption to a more normal figure of approximately 1,000 m3/d, for instance by the use of shorter floats and wash and reuse of treated weak wastewater for soaking.

Install and use precipitation of chrome from the tanning liquor by the use of lime. Recover the chrome-hydroxide for reuse in tanning or for treatment as hazardous waste.

Repair the systems for separation of flows in the beamhouses and enforce the separation by proper instruction of personnel.

Rehabilitate the wastewater treatment works and control the pH, flocculation and biological process (sludge age etc.).

Increase the size of the evaporation lagoons if required to cater for the wet season.

Upgrade the laboratory, provide chemicals and reagents and provide manuals for the analytical and monitoring work.

Start monitoring the operation of the wastewater treatment systems, the treatment effect and the discharge to the lake.

Project Opportunity (A 2)

Title: Training of Governmental staff in industrial pollution control with focus on combination of abattoir and tannery
Combined training project on abattoir and tannery waste/wastewater and bio-filter wastewater treatment with sludge composting

Background: The Botswana Meat Commission (BMC) at Lobatse is is a good example of a combination of abattoir and tannery. Many years of effort has enabled it to succeed in cutting down on water consumption and to finding alternative ways of treating and disposing of wastewater.

There is a treatment plant for the abattoir wastewater comprising anaerobic pond pre-treatment and bio-filters, which are in working order. At present the treated wastewater is disposed of on land. Plans are at hand to discharge the pre-treated abattoir wastewater into the relatively new Lobatse Town Council sewerage system.

BMC has a laboratory and a chemist, but to form a part of a training project and to make more frequent and complete analyses possible, there is a need for laboratory support in the form of additional equipment, reagents etc. There is also a need for an operation manual for the effective operation of the treatment plant.

The present handling of screenings containing paunch contents and dung is not satisfactory and is a cause of pollution to the Peleng River. A model composting unit could be erected to cater to selected organic waste from the Lobatse Town Council (see Project Concept B).

The tannery combined with the abattoir is working very well and has a capacity of 1,200 hides per day to the wet blue stage. The wastewater is treated by flotation for the removal of proteins. There are also mixing and aeration tanks. All the tannery wastewater is pumped to evaporation lagoons of 3 -4 ha situated not far from the Lobatse Town Council sewage ponds.The arrangement with evaporation ponds has made it unnecessary to keep separate the various streams of wastewater in the tannery - all is evaporated - and there is no water pollution. Investigations are carried out to control the groundwater in the area.The tannery benefits from the fact that the commission is self-sufficient with hides. They are fleshed in the BMC abattoirs at Lobatse and Francistown and only chilled before tanning. The only soaking needed is for approximately 150 hides per day from Maun.

At the Lobatse abattoir, all kinds of by-products are recovered, such as blood-, bone- and carcass-meal, tallow etc. The BMC Francistown abattoir is brand new and has incorporated all the results of the experience at Lobatse. It can demonstrate full use of by-products, low water consumption, pre-treatment of wastewater, discharge into the FTC public sewer, pond treatment and final disposal by irrigation. There is a need for a composting plant similar to that mentioned for Lobatse above.

In Lobatse, there is also available equipment for precipitation of proteins and treatment and reuse of wastewater from the abattoir. This equipment is not in operation today but could be used as a demonstration plant. The treated wastewater could be used in the tannery, and various agents could be tested and demonstrated for the flotation of proteins. These facilities would add to the training programme and possibly break new ground for water and by-products recovery.

Detailed information on processes, water use, flow diagrams, chemical- and water-balances is available and need only be updated. A training package would be developed (see Project Concept C), and include all relevant data on the industrial processes, by-products recovery, water use and waste treatment facilities. For training on the anaerobic and bio-filter treatment plants, support could come from Water Training in the United Kingdom or other recognized institution. The output for this on-site training would be solid experience in the field, combined with complete documentation on processes, treatment, specific figures on waste and treatment results etc. Technical/environmental staff from both industry and environmental units of government authorities should participate together to increase their understanding and contribute to their experience.

For staff to be trained, length of courses and the combination of training of higher and lower technical staff in parallel, see above under Project Opportunity (A 1).

Project Concept B

Title: Composting Unit - Pilot Plant (Phase I)

Background: Solid wastes produced in the agro-based industries and in municipal wastewater treatment plants can in many cases be used by farmers as fertilizers. This requires that the solids are "neutralized" with regard to pathogenic bacteria and dewatered. With the volume of waste thus reduced, it is less expensive to transport and therefore more attractive to farmers. In the report it was suggested that a composting unit be established as part of the second phase of the programme. This unit could be used as a model for further development in the participating countries.

Objective: To validate the viability of a composting plant for degradation of organic wastes produced in agro-industrial and municipal wastewater treatment facilities.

Output: A fully-operational pilot plant for composting organic wastes for agricultural use. The pilot plant operation will be suitable for use as a demonstration unit for participating countries.

Activities: A composting pilot plant will be established at a suitable place in one of the participating countries. The plant will be situated close to an existing agro-based industrial plant which has and operating wastewater treatment plant containing an equipped laboratory and qualified staff. The plant will be used for demonstration purposes after the completion of the mechanical erection. Staff from authorities in the participating countries will be invited to take part in short courses, to be trained in the operation of the plant and application of its technology. The training to be held could be a part of a training programme as outlined under Project Concept A, Project Opportunity (A 2).

Project site: A possible site has been identified, namely the BMC plant at Lobatse, Botswana. Further possible sites might also be identified. The BMC plant should therefore be regarded as a proposal and not as a final decision.

Project Concept C

Title: Development of Training Packages for Teaching Agro-based Industrial Processes and Corresponding Wastewater Treatment Methods

Background: As presented in the national studies prepared for this programme, an urgent need has been identified for personnel in ministries to be trained in pollution control. This need was confirmed by the UNIDO consultants. At present there is inadequate enforcement of existing water legislation due, at least in part, to a lack of knowledgeable personnel. As illustrated in the report, inclusion of this type of training in a second phase of the programme would be appropriate. The target group would be those staff working in ministries/departments in each country responsible for industrial establishments, as well as personnel responsible for environmental protection, industrial discharge and/or pollution control. Persons eligible for training should have, as a pre-requisite, a background in engineering. Before the training can be initiated, appropriate training packages will have to be developed, including both theoretical and pratical related material.

Objective: To enable UNIDO to hold training courses as outlined in Project Concepts (A) and (B) by developing training packages.

Output: Training packages consisting of training manuals and course documentation on the issues presented below.

Activities: A sub-contractor will produce the training packages in accordance with guidelines prepared by UNIDO. The material will be used at four-week courses which will also include field visits to appropriate demonstration sites. The following issues will be included in the training:

(a) Focus on industrial production processes with presentation of options for re-use/recycling of water and raw materials in agro-based industries such as textiles, breweries and tanneries;

(b) Wastewater treatment technologies with presentation of processes suitable for treatment of discharges and residues from the industrial subsectors. Included will be activated sludge, bio-filter, and anaerobic/ facultative pond treatment, as well as alternatives such as irrigation and evaporation;

(c) Establishment of control programmes and sampling and monitoring of discharges;

(d) Case-studies from developing countries in the African region;

The training packages are envisaged to be used at regional courses with participants from a number of countries. The local experience will be presented by locally-recruited trainers who will assist in the implementation of the courses.

Project size: n.a.

Annex II

INSTITUTIONS AND PEOPLE SEEN IN THE FIELD

BOTSWANA

UNDP:	Mr.F.Tissot, Res Rep Mr.S.R.Nhongo, Dep Res Rep Mr.L.L.Oriana-Vieyra, JPO
Ministry of Mineral Resources and Water Affairs:	Mr.M.Pearson, Planning Officer III Department of Mines Mr.T.C.Dikgaka, Mining Commissioner Department of Water Affairs Mr. M. Sekwale, Director Mr. O. A. Masedi, Principal Water Engine O&M Mr. B. O. Lindqvist, Advisor O&M Mr. W. J. Lewis, Sr. Water Quality Adviser Mr. F. Magibisela, Sr Water Engineer (Pollution)
Ministry of Commerce and Industry, Department of Industry	Mr.D.Tsheko, Assistant Director Mr.G.Kombani, Principal Industrial Officer Ms.D.B.Gaboutloeloe, Princ. Industrial Officer Ms.T.Ndzinge, Senior Industrial Officer Ms.E.M.Ditshego, Senior Industrial Officer Dr.A.S.Charway
Ministry of Local Government and Lands:	Mr.A.Selolegeng, Sr Public Health Engineer Department of Town and Regional Planning Mr.S.Bojase, Planning Officer
Ministry of Health, Community Health Department:	Dr.J.A.Kumaresan, Epidemiologist
Swedish International Development Autority:	Ms.M.Husen, Programme Officer
Botswana Meat Commission, Francistown:	Mr.K.S.Bingana, General Manager Mr.N.S.Du Plessis, Dep Chief Engineer Botswana Meat Commission, Lobatse Mr.A.K.Mosweunyane, Chief Engineer Mr.S.Jonsson, Tannery Manager
Sashe Silk Factory:	Mr.D.W.Mills, Plant Manager
Pilane Leathers (Pty) Ltd:	Mr.C.R.Rangarajan, Plant Manager

ETHIOPIA

UNIDO:	Dr.P.Manoranjan, UNIDO Country Director Mr.J.Brisson, JPO Mr.D.Mebratu, National Expert
Ethiopian Valleys Development Studies Authority:	Dr.Z.Abate, General Manager
Ministry of Industry:	Mr. Bacry Yusuf, Vice Minister - Development Mr.D.Assefa, Head of Technology & Planning
Ministry of Health:	Dr.G.Tadesse, Vice Minister
Department of Environmental Health:	Dr.A.Kumie, Head of Department

	Mr.B.Tegegne, Sect. Chief, Water & Sanitation
Office of the National Committee for Central Planning:	Mr. Z.Teklu, Commissioner
Water Resource Commission:	Mr.K.Achamyeleh, Vice Commissioner
Water Resources Development Authority Central Laboratory:	Mr.B.Destu, Head of Laboratory Mr.Z.Chafamo, Biologist
Department of O&M, Manpower Development & Employee Relations:	Mr. M. Musssie, Department Head Department of Hydrogeology & Engineering Mr. G. Eshete, Head of Division,
Ethiopian Institute of Geological Survey:	Mr.M.Negewu, Head of Central Geological Laboratory
Ethiopian Authority for Standardization:	Mr.E.Terefe, Head of National Quality Control and Testing Centre Mr.T.Geno, Sr Testing Officer Mr.E.Jiffar, Testing Officer Mr.D.Fufa, Testing Officer
Swedish International Development Authority.	Mr. O Jamtin, First Secretary(Dev. Co-op) Mr. . Olsson First Secretary (Dev. Co-op.)
National Distilleries and Liquor Factories,:	Mekanissa Alcohol Factory Mr.W.Teffera, Plant Manager Mr.S.Bekele, Production Head Mr.T.Emma, Process Engineer
Addis Ababa Brewery:	Mr.S.Bisrat, Manager Mr.S.Mehory, Technical Manager Mr.B..Seyoum, Ass Production Manager
Awash Tannery:	Mr.A.Yusuf, Production Manager Mr.S.Mebrahtu, Quality Control Dept. Head
Akaki Textile:	Mr.S.G/Kidan, Technical Manager
Ethiopian Tannery at Edjersa-Modjo:	Mr.K.Chekol, Deputy Manager Mr.M. Gebeyehu, Maintenance Dept. Head Mr.A.Mohammed, Laboratory Head Mr.A.Tefera, Effluent Treatment Plant Operator

LESOTHO

UNDP:	Mr.Q.Noaman, Res. Rep. Ms.M.Symmonds, Ass. Res. Rep. (Programme)
Ministry of Justice:	Mr.K.R.Tampi, Crown Agent
Ministry of Water, Energy and Minerals:	Mr.A.Mosaase, Principal Secretary (Ag) Mr.M.E.Macaskill, Dep. Princ. Secr. (Ag) Mr.C.N [illegible] Senior Planning Officer
Water and Sewerage Branch:	Mr.L.Pel[illegible]naging Director Mr.K.Kariuki, Chief Engineer Mr.F.Masilo, Senior Engineer Mr.J.L.Mohosho, Senior Engineer

Department of Water Affairs:	Mr.S.Makhoalibe, Director Mr.T.Moshabesha, Head of Hydrogeol. Division Ratjumose Sewage Treatment Works Mr.Seala, Treatment Works Supervisor
Maseru Water Supply:	Mr.N.Nkhale, Chief Technical Officer Mr.E.Panyane, Chemist Mr.C.Mashwane, Lab. Techician
Department of Mines and Geology:	Mr.P.M.Lerotholi, Commissioner of Mines Ms.N. Mpatuoa, Principal Geologist
Village Water Supply Section (Ministry of Interior, Chieftainship Affairs and Rural Development):	Mr. J. J. Christen, National Construction Engineer (Program Director Helvetas)
Department of Industry (Ministry of Trade and Industry):	Mr. J. B. Maleane, Commissioner of Industry Mr. A. D. Adhikari, Chief Technical Advisor
UNIDO:	Ms. L. Leuta, Chief Industry Dev. Officer Ms. B. T. Kolosoa, Sr. Industry Dev. Officer
Ministry of Health:	Mr. M. A. Makhetha, Chief Health Inspector (Ag) Mr..N.T.Mosese, Principal Health Inspector (Ag) and Sr Tutor/Co-ordinator, National Health Training College
Ministry of Planning, Economic and Manpower Development, Development Policy Unit:	Ms. M. C. Mphutlane, Economist
Bureau of Statistics:	Mr. K. S.Nyokong, Chief Statistician Mr. E. Kiberu, Statistical Officer
Swedish International Development Authority:	Mr.P.Lundell, Sr Programme Officer
N. A. F. C. National Abattoir & Feedlot Complex:	Mr.T.P.Tsotetsi, Service & Maintenance Manager's Counterpart
Lesotho Dairy Products (Pty) Ltd:	Mr.D.F.Dickinson, Plant Manager
Lesotho Fabric Processors (Pty) Ltd:	Mr.A.Bannister, Group Technical Manager Mr.L.Guasta, Consultant Mr.A.White, Plant Manager
CGM Industrial (Pty) Ltd:	Ms.F.Chang, Owner
Basotho Fruit and Vegetable Canners:	Mr.R.B.Hassan, Consultant Production Managera
Basotho Tanning (Pty) Ltd:	Mr.P.Mafereka, Tanning Manager
Maluti Mountain Brewery:	Mr.C.Trumpp, Production Manager Mr.K.Manale. Maintenance Engineer Mr.P.Lebesa, Brewing Manager Ms.M.Mothepa, Brewer Ms.N.Nkonyane, Brewer
UGANDA	
UNDP:	Mr.T.Teshome, Res Rep
UNIDO:	Mr.B. Larsen, JPO

Gauff Ingenieure:	Mr.N.B.Droruga, Senior Water Engineer
Ministry of Industry and Technology:	Mr.G.E.Okutu, Permanent Secretary Dr.S.P.Kagoda, Commissioner for Technology
Ministry of the Environment Protection:	Mr.H.S.Opika Opoka, Permanent Secretary Mr.T.O.Achere Commissioner Mr.F.Turyatunga, Sr Environmental Officer Ms.D.Etori, Wetland Officer Mr.C.Sebukeera, Environmental Officer
National Water and Sewage Corporation:	Dr.C.Wana-Etyem,Operations Manager, Ag M/D Mr.C.Luswata-Lule, Chemist/Analyst
WT Water Training:	Mr.P.L.O'key, Project Manager Mr.J. S.Kibirige, Training Officer Mr.J.Mundua, Training Officer Mr.Abdallah, Training Officer
Gaga Water Works and Pumping Station:	Mr.O.Fred, Shift Overseer
Kampala Sewage Works:	Mr.J.Nsubuga, Ag Sr Superintendent of Works
Department of Water Development:	Mr.B.K.Kabanda, Commissioner for Water Development Mr.S.Nsubuga, Senior Analyst, Head of Water Quality and Pollution Control Section Mr.J.K.Rubalema, Water Engineer
Ministry of Labour:	Mr.S.K.Nsubuga, Chief Factories Inspector Dr.D.A.Ogaram, Dep Chief, Occupational Health and Hygiene Department
Uganda Leather & Tanning Industries Ltd, Jinja:	Mr.M.Doi-Onume
Nyanza Textile Industries Ltd, Jinja:	Hon E K Rwakakooko, Chairman, Ag M/Director Mr.E.Kadu Mukasa, Production Executive Mr.N.Dayo, Ass. P Q C Manager Mr.U.Birantana, Mechnical Engineer
Uganda Breweries Ltd, Kampala:	Mr.N.Matembe, Head Brewer
Sugar Corporation of Uganda Ltd, Lugazi:	Mr.V.Sivaprailasam, Director of Works Mr.S.V.Joshi, Dep Manager, Processes Dr.P.M.Honavar, Distillery Manager Mr.J.O.Isodo, Manager Technical Control
Uganda Fisheries Enterprise, Jinja:	Mr.H.Bidasala-Igagak
UNITED REPUBLIC OF TANZANIA	
UNIDO:	Mr.A.Krasiakow, Unido Country Director Mr.Akim, Assistant Administrator
National Environment Management Council. (Parastatal under Ministry of Lands, National, Resources and Tourism).:	Mr.G.L.Kamukala, Director General Mr.B.Paulsson, Princ. Environmental Advisor Mr.S.S.Mkuula, Princ. Pollution Control Off.

Ministry of Water, Energy and Minerals.:	Mr.F.J.Gumbo, Head of Water Quality Laboratory Mr.I.S.Kimwagu, Water Law Officer
Swedish International Development Authority:	Mr Arne Strom, Country Representative Mr.Claes Leijon, Sr. Progr. Officer, Industry
University of Dar es Salaam:	Dr. D.A.Mashauri, Head of Environmental Engineering Section Dr. T.S.A.Mbwette, Head of Water Laboratory, Department of Civil Engineering
UNIDO Consultant:	Mr. G. Clonfero
Tanzania Leather Associated Industries:	Mr. S. Massay
Ministry of Agriculture & Livestock Development:	Mr. E. Muyinga
Friendship Textile Mills Ltd:	Mr.A.M.A.Sirima, Chief Engineer
Tanzania Breweries Ltd:	Mr.W.N.Mwingira, Production Controller Mr.T.A.Sawe, Head Brewer
Twiga Chemical Industries (T) Ltd:	Mr.F.N.Kaaya, Factory Manager
DarBrew Ltd:	Mr.E.C.Msangula, Senior Chemist
Tanganyika Packers Ltd:	Dr.P.E.Kiiza, Technical & Operational Manager

ZAMBIA

UNDP:	Mr.A.M.Sallah, Res Rep
UNIDO:	Mr.E.A.S.Taylor, UNIDO Country Director Mr.E.Kjerstad, Junior Professional Officer
Office of the Prime Minister, Decentralization Division:	Mr.M.C.Sata, Minister of State, MP Mr.E.Longwe, Director Decentralized Planning Mr.F.C Chiwele, A/Ass. Dir. Decentr. Planning
Ministry o Water, Lands & Natural Resource Department of Water Affairs:	Mr.L.L.Mbumwane, Dep. Director
National Resources Department:	Ms.I.Simuunza, Sr. National Resources Officer Mr.W.Ndhlovu, Sr. National Resources Officer Mr.W.Kalunga, Sr. National Resources Officer
Ministry of Commerce and Industry, Department of Industry	Mr.M.F.Kancheya, Director of Industry Mr.J.Nakalonga, Senior Economist
University of Zambia, Civil : Engineering Department.	Mr.Z.Phiri, Lecturer, National Expert
Lusaka Rural District Council (Kafue):	Mr.J.M.Bwembelo, District Executive Secretary Mr.A.D.Mukutu, Development Secretary Mr.K.Mukela, Ag FCIS/Finance Ms.B.Chilala, Social Secretary Mr.J.Ngosa, Water Engineer, MAWWA

	Mr.D.W.Mwanza, Senior Health Inspector
Lusaka Water & Sewerage Co Ltd:	Mr.E.G.K.Nyirenda, Counterpart Director Ms.N.P.Okeowo, Sr Biochemist Mr.L.B.Musonda, Sr Lab Technician
Swedish International Development Authority:	Dr.K.Nystrom, Head of Development Co-operation Office
Aquaconsult (Z) Ltd:	Mr.J.F.Mwale, General Manager
Lusaka Domestic Sewerage Works:	Mr.M.Miti, Laboratory Assistant
Cooper (Z) Ltd:	Mr.J.Mwala, Prod Manager
Zambia Breweries Ltd:	Mr.W.Kool, Operations Controller
National Breweries:	Mr.M.D.Sibanda, Brewer
Zambia Cold Storage Corporation:	Mr.A.K.Liambela, Regional Engineer
Zambia Pork Products, SME (Self Management Enterprise):	Mr.S.B.Mutinta, Meat Technologist
Nitrogen Chemicals of Zambia:	Mr.N.Muleba, Environmental Hygiene Superintendent Mr.P.Chimphonda, Safety Superintendent Mr.C.Sililo, Area Safety Officer Mr.E.Kalenge, Area Safety Officer
Kafue Textiles (Z) Ltd:	Mr.N.K.Gandhi, Mechanical Engineer Mr.K.S.Tripathi, Dye House Manager
Zambia Bata Shoe Company Ltd:	Mr.Tim Peake, Tannery Manager

ZIMBABWE

UNIDO:	Mr.H.J.Friederich, Programme Officer
Department of Water Resources:	Mr.H.Choga, Dep. Dir. of Operations Division Mr.B.C.Chiworeso, Water Pollution Control Officer
Ministry of Environment and Tourism:	Mr.M.D.Munemo, Dep.-Dir. of Natural Resources Mr.N.K.Karombe, National Resouces Officer Ms.S.Ncube, National Resources Officer
Ministry of Industry and Commerce:	Mr.B.Mauwa, Under Secretary (Plan. and Policy) Mr.E.Ndlovu, Under Secretary (Light Industry) Mr.G.Garapo, Ass. Secretary (Chemical Ind.) Mr.F.Bango, Ass. Secretary (Int. Ec. Co-op.) Mr.A.Rambo, Sr Admin Officer (Int. Ec. co-op.)
Ministry of Higher Education:	Mr.Mambo, Deputy Secretary
Harare City Council:	Mr.H.Chiriseri, Trade Effluent Inspector
Swedish International Development Authority	Ms.B.Berggren, Head of Dev. Co-op. Mr.B.Nilsson, Programme Officer

Zimbabwe Phosphate Industries Ltd:	Mr.E.M.Makonese, Managing Director Mr.T. Mashingaidze, Technical Manager
Lancashire Steel (Pvt) Ltd:	Mr.W.Tabvuma, Quality Control Manager
Zimbabwe Iron and Steel Company Ltd:	Mr.R.Muran, Water Engineer
Zimbabwe Mining & Smelting Company (Pvt) Ltd(Kwekwe Division):	Mr.H.Nyamadzawo, Health Safety & Environmental Protection Manager Mr.T.F.Dandadzi, Health Safety and Environmental Protection Officer Mr.M.Lamprecht, Plant Foreman, MFS Plant
Imponente Tanning:	Mr.J.C.Touguinha, Tannery Manager
Lonrho Zimbabwe (Pvt) Ltd, Athens Mine:	Mr.M.Daverin, Mine Manager Mr.S.Kitshoff, Reduction Officer
Hunyani Paper & Packaging Ltd:	Mr.C Molam, Managing Director Dev. & Techn

Annex III

LIST OF INDUSTRIAL FACILITIES VISITED

Sector	Country
Tanneries	
Basotho Tanning (Pty) Ltd	Lesotho
BMC Lobatse	Botswana
Pilane Leathers (Pty) Ltd	Botswana
Imponente Tanning	Zimbabwe
Bata Shoe Tannery	Zambia
Uganda Leather and Tanning Ind. Ltd	Uganda
Awash Tannery	Ethiopia
Ethiopian Tannery	Ethiopia
Abattoirs	
Tanganyika Packers Ltd	United Republic of Tanzania
National Abattoirs (NAFC)	Lesotho
BMC Francistown	Botswana
BMC Lobatse	Botswana
Zambia Cold Storage Corporation	Zambia
Zambia Porc Products	Zambia
Breweries	
Tanzania Breweries	United Republic of Tanzania
Dar Brew Ltd	United Republic of Tanzania
Maluti Mountain Breweries	Lesotho
Zambia Breweries	Zambia
National Breweries	Zambia
Uganda Breweries Ltd	Uganda
Mekanissa Distillery	Ethiopia
Addis Ababa Brewery	Ethiopia
Sugars	
Sugar Corporation of Uganda	Uganda
Textiles	
Friendship Textile Mills Ltd	United Republic of Tanzania
Lesotho Fabrics Processors (Pty) Ltd	Lesotho
CGM Industrial (Pty) Ltd	Lesotho
Shashe Silk (Pty) Ltd	Botswana
Kafue Textiles of Zambia	Zambia
Nyanza Textile Industries Ltd	Uganda
Akaki Textile	Ethiopia
Other agro	
Basotho Fruit and Vegetable Canners	Lesotho
Lesotho dairy Products (Pty) Ltd	Lesotho
Uganda Fisheries Enterprise	Uganda
Pesticides	
Twiga Chemical Industries (T) Ltd	United Republic of Tanzania

Cooper (Z) Ltd	Zambia

Fertilizers

Zimbabwe Phosphate Industries Ltd	Zimbabwe
Nitrogen Chemicals of Zambia (NCZ)	Zambia

Mines/metals

Lancashire Steel (Pvt) Ltd	Zimbabwe
Zimbabwe Iron and Steel Co Ltd	Zimbabwe
Zimbabwe Mining and Smelting Co (Pvt) Ltd	Zimbabwe
Lonrho Zimbabwe (Pvt) Ltd	Zimbabwe

Bibliography

A. General

Maurice Aspinall,.Support to Senai-Cetiqt Applied Research Unit, UNIDO, DP/BRA/87/033/11-11, January 1990

L. Brynolf, and B Hawerman, Legal and Administrative Aspects on Water Pollution Control in Developing Countries, Wat. Sci. Tech., Vol. 14, 1982

B. Carmichael, and K M Strzepek,.Industrial Water Use and Treatment Practices,.UNIDO, Vienna, 1987.

Malin Falkenmark, The Massive Water Scarcity Now Threatening Africa - Why Isn't it Being Addressed?, Ambio Vol. 18, No.2 1989

D. D. Mara, Design Manual for Sewage Lagoons in the Tropics,.1975

D. D. Mara, and S. Cairncross, Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture,. WHO/UNEP,.Geneva, 1989

J. Rennerfelt, and L Ulmgren,.Vattenreningsteknik, Stockholm, 1975

Dr. Nafis Sadik, The State of the World Population 1990, UNFPA, United Nations Population Fund, New York

D. Winters, Report on the Kenyan Leather Industry, Its Environmental Impact and Measures to Mitigate Such
Environmental Degradation, for the Swedish Development Cooperation Office (SIDA) and the Water Quality & Pollution Control Division, Ministry of Water Development, Nairobi,.October 1979

D. Winters, Techno-economic Study on Measures to Mitigate the Environmental Impact of the Leather Industry, Particularly in Development Countries,.UNIDO, Vienna, 22 March 1984

Action on the Environment: the role of the United Nations,. UNEP, 1989

Agreement on the Action Plan for the Environmentally Sound Management of the Common Zambezi River System,. Final Act,. UNEP,. Harare, 26-28 May 1987

Environmental Considerations in the Leather Producing Industry, UNIDO/UNEP, Vienna, 1975

Human Development Report,.UNDP, New York, 1990

Management and Control of the Environment, WHO/PEP/89,.1. 1989

Towards an Integrated Industrial Development Programme for the PTA,, Regional and Country Studies Branch, UNIDO, in co-operation with Africa Countries Programme,.11 April 1990

Reuse of Effluents: Methods of Wastewater Treatment and Health Safeguards,, WHO Technical Report Series, No 517,.Geneva, 1973

UNIDO Environment Programme, proposed by the Director-General at the sixth session of the Industrial Development Board. IDB,.6/3, 29 March 1990

Zacplan; Zambezi River System Action Plan,.SADCC Coordinating Unit,. Implementation of Category 1 Projects. Zacpros 1-8. Soil and Water Conservation etc.

B. Country studies prepared for this regional meeting

B. C. Chiworeso, Industrial Waste Water Management in Zimbabwe,Country Paper, 1990

N. Droruga, Report on the Purification of Industrial Wastewater - Uganda. Country Paper, April 1990

W. K. Kariuki, and F. K. Masilo, Country paper on industrial wastewater treatment in Lesotho,.June 1990*

F. Magibisela,.Purification of Industrial Wastewater in Botswana,.Draft Country Report,.1990

Dr. D. A. Mashauri, Mr. S. S. Mkuula, Mr. F. M. Mpendazoe and Mr. F. J. Gumbo, Programme on Purification of Industrial Wastewaters (Phase 1),.Country Paper Tanzania

D. Mebratu,.Industrial Waste Management System for Akaki; An opportunity study report,.October 1989

D. Mebratu,.Programme on Industrial Wastewater Purification, Preliminary Country Paper of Ethiopia for UNIDO, May 1990

Z. Phiri, Industrial Wastewater Management in Zambia.Country paper for the programme, National Expert, June 1990

C. Sebukeera, Programme on the Purification of Industrial Wastewater - Uganda National Report, 1990

C. Other country specific references

1. Botswana

Botswana Meat Commission, Francistown, Commemorative Issue, 12 June1990

Botswana National Water Master Plan Study,.Draft Final Report, Vol 11 - Water legislation.SMEC, WLPU, SGI for Department of Water Affairs,.April 1990

First Annual Report on Water Quality and Pollution Control,. WLPU for Department of Water Affairs, May 1990

Pollution Control Guidelines No.2,.Wastewater reuse and discharge guidelines. DWA 1988

Water Act. Act 40, 1967

Botswana, Development Co-operation Report.Financed from External Sources 1988. UNDP 1989

Marung, Vol 8 No 42, June/July 1990

Magnitude and Sources of Water Pollution in Botswana,. First Annual Report on Water Quality and Pollution Control, WLPU Consultants for Department of Water Affairs,. May 1990

Atmospheric Pollution (Prevention), Act, 1971, Chapter 65:04

Air Pollution Control. Annual Report 1988.Department of Mines, March 1989

Town Councils (Public Sewers) Regulations, 1982, issued under the Townships Act (Chapter 40:02)

Preliminary Investigation with a View to Reclaiming Wastewater in Gaborone,.Lyonnaise des Eaux,.1988

2. Ethiopia

K Lima, The Institutional and Legal Framework: Appropriate Environmental Legislation & Institutional Structures, May 1990

M. Mesfin, Industrial Development and Its Impact on the Environment, May 1990

Ethiopia, National Conservation Strategy Conference 1990,.Volumes 3 and 4:

Framework for Environmental Protection Programme within the Valleys or Basins of Ethiopia. EVDSA,. November 1988

3. Lesotho

A. C. Braby, A Review of Commerce & Industry,.Lesotho (Pty) Ltd, Lesotho, 1990

Act No. 22 of 1978. Water Resources Act

Consultancy on Building Rules & Regulations, The Rationalization & Consolidation of Legislation re. Water & Sewerage Management and the Drafting of Legislation to Create a Water and Sewerage Authority. The United Nations Centre for Human Settlements, Habitat. M. St C. Batson. Draft of Water and Sewerage Order, 1990
Draft of Apportionment Committee Regulations, 1990

Draft of Drainage and Sanitation Regulations, 1990

Draft of Standards of Quality for Effluent Discharges Regulation, 1990

Draft of Standards of Quality for Potable Water Regulations, 1990

Draft of Abstraction and Discharge Permits Regulations, 1990

4th Five-Year Plan (1986/87 -90/91),.Ministry of Planning, Economic and Manpower Development

Lesotho National Environmental Action Plan, Implementation Proposals. Ministry of Planning, Economic and Manpower Development,.February 1990

Industrial Sector Study Lesotho, Volume One: Executive Summary. Baffoe & Associates (Pty) Ltd, Louis Berger International Inc. Ministry of Trade and Industry,.August 1987

Lesotho, Industrial and Agro-industries Development Project, Pre-appraisal mission, 1989

Development Co-operation Lesotho, 1988 Report, UNDP, November.1989

4. Uganda

UNIDO Industry Sector Programming Mission to Uganda,.Report. PPD/R.36,.23 May 1990

Development Co-operation Uganda. 1988 Report,.UNDP, November 1989

Laws of Uganda: Public Health Act, 1964, Chapter 269

Waterworks Act, 1964, Chapter 137,

5. United Republic of Tanzania

Haskonig and M-konsult, Study on Solid Waste Management and Pollution Caused by Sewerage Systems in Dar es Salaam,.Ministry of Water, Dept. of Sewerage and Sanitation

B. Paulsson, The Environment Situation in Dar es Salaam/Morogoro,.Principal Advisor, NEMC

Act No 42 of 1974, Water Utilization (Control and Regulation)

Act No 10 of 1981. Water Utilization (Control and Regulation). (Amendment 1981.)

Act No 11 of 1983. An Act to provide for the establishment of the National Environment Management Council

Draft - Solid Waste Management (November 1988)

Zero draft - Pollution (December 1988)

Appropriate Technologies to Reduce Waste in Selected Manufacturing Industries in Tanzania, Workshop, Dar es Salaam and Morogoro, 17-26 October 1988

Msimbazi River: Dar es Salaam. B Paulsson

Wilander.KTH, A proposal for strengthening environmental laboratory facilities in Tanzania and training of laboratory personnel, Stockholm for NEMC, 1988

F. M. T. Mpendazoe, Environmental Impact Assessment for the Sugar Industry in Tanzania,.NEMC.Draft, January 1990

6. Zambia

Laws of Zambia: Water Act, 1978

Local Administrative Act (Act 15 of 1980)

The Local Administration (Trade Effluent) Regulations, 1985

Environment Protection and Pollution Control Act, bill to the Parliament, gazetted

Towards an integrated industrial development programme for the PTA, Regional and Country Studies Branch, UNIDO,.11 April 1990

Feasibility Report for the Rehabilitation of Water Supply and Sewerage Schemes in Kafue Township. Aquaconsult (2) Ltd. 14 April 1990

Proposed amendments to Investment Act No. 5 of 1986 of the Laws of Zambia

4th National Development Plan, 1987-91.National Commission for Development Planning, December 1986

Economic Report 1989. National Commission for Development Planning, Lusaka,.November 1989

Development Co-operation Zambia. 1988 Report,.UNDP,.July, 1989

7. Zimbabwe

B. R. Conard and E. A. Devuyat, Application of INCO's SO2/air cyanide Removal Process to Industrial Effluents,

Water Act. Chapter No 41, 1976

Management and Control of the Environment, WHO/PEP/89.1

The Manufacturing Sector in Zimbabwe,.UNIDO, 13 November 1986

1st Five-year National Development Plan, 1986 - 1990, Volume 1, Zimbabwe.April 1986

Industrial Development Review Series PPD.63, UNDP, Regional Country Studies Branch, 2 December 1987

Development Co-operation Zimbabwe, 1988 Report, UNDP, July 1989

D. Leather industry references

D. Winters, for the Swedish Development Cooperation Office (SIDA) and the Water Quality & Pollution Control Division;

Report on the Kenyan Leather Industry, its Environmental Impact and Measures to mitigate such environmental degradation;

Regional Hides and Skins, Leather and Leather Products Improvement Scheme..UNIDO US/RAF/88/100/11

Technical Report: Effluent Treatment and Solid Waste Discharge,.Sudan - Kenya - Somalia - Tanzania,.Based on the work of A Lesuisse, Leather Industry Consultant

Ministry of Water Development, Nairobi, October 1979;

D. Winters, Techno-Economic Study on Measures to Mitigate the Environmental Impact of the Leather Industry, Particularly in Development Countries. UNIDO Vienna, 22 March 1984;

Environmental Considerations in the Leather Producing Industry, UNIDO/UNEP Vienna 1975;

Preparation of Action Programmes for the Rehabilitation of the Leather Subsector in Tanzania, Final Report, Ministries of Industry and Trade. bmb Management Consulting for Development, October 1989.