UNEP

UNEP/UNDP/DUTCH
Joint Project on Environmental Law
and Institutions in Africa

undp

THE EAST AFRICAN SUB-REGIONAL PROJECT

DEVELOPMENT AND HARMONISATION OF ENVIRONMENTAL LAWS

VOLUME 2

REPORT ON THE DEVELOPMENT AND HARMONIZATION OF ENVIRONMENTAL STANDARDS IN EAST AFRICA

JUNE 1999

UNEP/UNDP JOINT PROJECT ON ENVIRONMENTAL LAW AND INSTITUTIONS IN AFRICA

THE EAST AFRICAN SUB-REGIONAL PROJECT

DEVELOPMENT AND HARMONIZATION OF ENVIRONMENTAL STANDARDS

VOLUME 2

REPORT ON LEGAL AND INSTITUTIONAL ISSUES IN THE DEVELOPMENT OF ENVIRONMENTAL STANDARDS

June 1999

TABLE OF CONTENTS

PREFACE

Environmental law is an essential tool for the governance and management of the environment and natural resources. It is the foundation of national and regional policies and actions to ensure that the use of natural resources is done equitably and sustainably.

In the East African sub-regional countries of Kenya, Tanzania and Uganda have, since 1995, been developing and harmonizing various environmental laws in selected sectors within their region. The process of developing and harmonizing environmental laws is intended to lead to the enactment or amendment of the internal legislative, regulatory and administrative framework of each country. Such change has been harmonized at a sub-regional level where the three countries have agreed on legal principles, definitions and substantive legal provisions to govern a segment or matter of the environment or natural resource sector.

The volumes produced by the UNEP/UNDP/Joint Project on Environmental Law and Institutions in Africa, East African Sub-regional Project, are intended to build capacity in Kenya, Tanzania and Uganda in environmental law. The East African Sub-Regional Project is a component of the UNEP/UNDP Joint Project on Environmental Law and Institutions in Africa funded by the Dutch Government. The underlying presupposition is that the three countries share similar historical and legal heritage and that the physical and historical situation in East Africa offered an opportunity to initiate and encourage dealing with environmental issues according to problem-sheds. The historical facts are that (a) there is a history of regional cooperation among the countries from colonial times; and (b) there is shared legal tradition which derives from common law origins. These two historical facts were relied upon to support development and harmonization of legislation on selected themes in the commonly shared environment.

The UNEP/UNDP Joint Project on Environmental Law and Institutions in Africa is funded by The Royal Dutch Government, as a pilot project, to work with selected countries towards development of environmental law and institutions in Africa. The purpose is to enhance the capacity of the countries to develop and enforce laws relating to environment and natural resources. Phase I of the Project which commenced at the end of 1994, and is scheduled to end in December, 1999, involves seven countries, namely: Burkina Faso, Malawi, Mozambique, Sao Tome and Principe, Kenya, Tanzania and Uganda. While activities in the first four countries focus on entirely national activities, the work in the three East African countries are focused on issues which are essentially of sub-regional character. The management of the Joint Project is based at UNEP within its environmental law activities and is directed by a Task Manager, who works under guidance of a Steering Committee. Members of the Steering Committee are UNEP, UNDP, FAO, The World Bank, IUCN Environmental Law Centre and The Dutch Government.

The Process For Development and Harmonization Of The Laws

Representatives of the three governments met in February 1995 to work out general principles and modalities for their cooperation.

A second meeting was held in May, 1995, to discuss the general terrain of topics amenable to development and harmonization of laws. The final decision on six priority topics was taken at their third meeting in February 1996.

The six topics which were selected for the Project's activities are:

(i) Development and harmonization of EIA Regulations;

(ii) Development and harmonization of laws relating to transboundary movement of hazardous wastes;

(iii) Development and harmonization of the methodologies for the development of environmental standards;

(iv) Development and harmonization of forestry laws;

(v) Development and harmonization of wildlife laws; and

(vi) Recommendation for legal and institutional framework for the protection of the environment of Lake Victoria.

(vii) The seventh topic, development and harmonization of laws relating to toxic and hazardous chemicals was taken up in 1998 when the work on the first six was virtually complete. The three countries considered this as one of the critical issues in environmental protection in the sub-region.

For each of the topics, the governments jointly worked out generic terms of reference. However, each national team subsequently worked out country-specific terms of reference to reflect national legal and institutional situations, existing initiatives on the same task as well as existing priorities. The respective national consultants were also selected by the National Coordinating Committees (NCC), working in consultation with an officer at the UNDP country office.

The national consultants have now completed their work. In each case, the reports have enjoyed reviews by the national panels constituted under the aegis of the respective NCCs. Draft reports, as they evolved, were circulated to the consultants in the three countries. In many cases, the consultants were able to take the reports of their counterparts into account in finalizing their reports. Therefore, very high degree of harmonization of reports had been achieved before the consultants could meet together.

At the end, a workshop to finally harmonize the reports was held in 1998 in Kisumu, Kenya and was attended by the consultants for each topic for substantive discussions of their reports and to agree on recommendations to their governments. The objectives of the workshop were to; (a) ensure that recommendations for policies and law for the respective topics as far as possible, are in harmony; (b) promote the development of legal and institutional machineries which are comparable in all the three East African countries in the absence of an over-arching sub-regional framework;(c) harmonize the normative prescriptions and institutional machineries and therefore create an opportunity for harmonized enforcement procedures; and (d) create an opportunity for dealing with the respective environmental problems according to the problem-sheds, which are essentially sub-regional. The workshop was facilitated by Professor David Freestone, Legal Advisor, International and Environmental Law Unit of The World Bank and Mr. Jonathan Lindsay, a Legal Officer in Development Law Service at the United Nations Food and Agricultural Organization. The concept paper as well as the eventual report for the Workshop is in Annex I to this volume.

Thereafter, a meeting for Permanent Secretaries responsible for environment from the three countries was held and attended by the national coordinators. The Permanent Secretaries as accounting officers and policy leaders in their ministries were fully briefed on the aspirations and activities of the project; how the project had developed and the process of harmonization. They assumed ownership of the outcome of the reports. They also resolved that the stage was well-set for development of a sub-regional binding instrument on environmental management. Their debate recognized that a legally binding instrument in the form of a protocol within the framework of the Treaty of East African Cooperation would take time to evolve and could involve a broad cross-section of ministries. For these reasons, they resolved that as an interim measure, they would sign a memorandum of understanding.

Subsequently, a Memorandum of Understanding on Cooperation in Environmental Management was entered into by the three governments on 22 October 1998 covering all the themes of the project and also covering other aspects which had not been envisaged in the project. One of the main features of the Memorandum of Understanding is a commitment to develop a protocol on environment management under the auspices of the proposed East African Treaty.

The governments of Kenya, Tanzania and Uganda are expected to take up the recommendations and the Memorandum of Understanding and implement the recommendations. In fact, the Permanent Secretaries specifically requested UNEP and its cooperating agencies in the Joint Project to assist in the development of the Memorandum of Understanding.

Meanwhile, the Joint Project has undertaken to produce the reports on the seven topics as stand-alone publications and as bases for national legislation. In addition, a report on the review of national projects related to environmental law and institutions has been prepared as part of the publications. The national reports were prepared by the National Coordinators in the three countries. This report is intended to assist in avoiding duplication of efforts and create a coherent synergy in reviewing and developing environmental laws.

This Volume comprises three reports prepared by the national consultants, harmonized at the joint workshop and finally accepted by the Permanent Secretaries. Its theme is the development and harmonisation of environmental standards in the East African sub-region. The report identifies priority areas requiring environmental standards and proposes that such standrds be regulated. Uganda has done the most work on this subject; some of its draft standards will be adopted into law soon. The report also presents criteria and methodologies for the measurement of the standards and areas of possible capacity building. The critical areas which need harmonisation at the East African sub-regional level are presented.

Because of its complexity the development and harmonization of environmental standards involved a wide cross-section of expertise. From Kenya the experts were four, namely: Francis Situma, E.L. Songole, F.K. Njuguna and M.A. Abira. The Tanzanian experts were three, namely: V.D. Shauri, S.A. Mapande and L.S. Kinabo; while the Ugandan team comprised C. Kyamanya, D.A. Ogaram, J. Aniku and Mr. K. Magunda. The general editorial work has been done by Robert Wabunoha from Uganda. Their contributions to this imporant volume is gratefully acknowledged.

UNEP and its partners in this project were delighted to support the developmetn of this initiative. However, the report has no official standing as such.

Address any comments or enquiries about these reports to:

Task Manager
UNEP/UNDP/Dutch Joint Project
Technical Cooperation Unit
Division of Policy Implementation
United Nations Environment Programme
P.O. Box 30552
NAIROBI, KENYA
Tel: 254 2 623815/624256/623480/623923
Fax: 254 2 623859/230198
email: charles.okidi@unep.org

OVERVIEW

Environmental standards in environmental management are an important tool which ensures the right to a clean and healthy environment for all people living on this earth. The countries of East Africa are undergoing a high level of socio-economic transformation which trend has an impact on the environment in terms of threatening the carrying capacity of the natural resources available. Use of environmental standards by these countries will therefore ensure that while the countries develop, discharges and emissions do not adversely and significantly harm the environment and natural resources. The environmental standards, when applied in this sub-region will ensure efficiency, and competitiveness in investments.

The Process of developing and harmonizing environmental standards under this project was started in 1997, when a regional workshop on methodology for the development of environmental standards was held in Kisumu, Kenya. It was attended by representatives from the regulatory authorities of, among others Kenya, Tanzania and Uganda, including some of the consultants who eventually prepared these country reports. The purpose of the workshop was to develop and harmonize the general criteria and methodology for the development of environmental standards. The national teams were thereafter required to apply the methodologies in an exercise to develop national reports and standards even if these are tentative.

The three countries approached the development of environmental standards in their respective countries using various data and information available at national levels, and focusing on the subjects that are a national priority.

Kenya Country Report

The Kenyan Country Report approaches the issue of environmental standards through the legal base of existing legislation and standards at national level as well as guidelines and norms offered at national and international levels.

A comprehensive legal review is given which shows that Kenya lacks a comprehensive legal and institutional mechanism to deal, among others, with issues of environmental standards. This situation, however, exists even though Kenya has a number of reports, policies, guidelines on the subject. The"existing Standards" which are shown in the report have no legal basis since they have not been formally enacted.

The report further reviews a number of critical cases to justify the need for establishment of environmental standards, most of which are concerned with emissions or discharges from industry and mobile sources, especially motorized vehicles.

The Kenyan Country Report further reviews, in great detail, scientific knowledge and technology on "environmental standards". This review is mostly from international sources such as International Labour Organization (ILO), World Health Organization (WHO), United Nations Industrial Development Organization (UNIDO); Organization for Economic Cooperation and Development (OECD) and International Standards Organization (ISO); among others. The review of scientific knowledge and technology relates to the importance of pollution control of air, water and soil.

The sources of the pollution are also reviewed. In all the areas under consideration, great detail is given to objectives, as well as priority areas needing control especially emission and discharge reduction techniques, among others.

On soil quality standards, the Kenyan report notes that no standards have ever been developed, although methods of analysis of soil were published in 1980. The report proposes standards for air, water and soil. On effluent discharge standards, proposals are given for inland waters and public sewers. Methodology on formulation, testing and enforcement of the standards is given using a logical framework. This includes comparison with other developing countries as well as with some developed countries.

The Kenya Country Report, at the end, provides a detailed capacity building proposal for the development and enforcement of the environmental standards. Capacity building will be required in institutions responsible for the various standards, in air quality management, training for water quality monitoring, laboratories for soil testing and equipment. At the sub-

regional level, with environment being a sphere of co-operation, to incorporate strategies for collaborative research and training in environmental standards will be quite appropriate.

In conclusion, the Kenya Country Report has a concentration on air quality issues thus showing it as a major problem in Kenya.

Tanzania Country Report

The Tanzania Country Report takes an approach fairly similar to that of Kenya. It is based on a comprehensive review of the laws, guidelines, norms and standards relating to air, water and soils. Most of the laws that exist have some relevance to standards, but are generalized and hence not easily enforceable in courts of law. The Water Utilization Act, however, is the only legislation which sets standards for water quality. Standards have also been developed for water quality, worker safety and consumer goods.

The report reviews standards and guidelines on environment by providing examples of legislation on ambient receptors, emissions, and specification standards in a theoretical setting. It further reviews national legislation on the matters relating to environmental standards. The report reviews the scientific knowledge and technology on environmental standards by providing, in a tabular form, proposals for waste water, maximum concentrations for metal pollutants in drinking waters, effluent standards, standards for organic substances, and receiving water standards.

While acknowledging the stage of Tanzania's industrial development, the report acknowledges the need to take precautions to ensure that the country does not suffer from heavy pollution. In this regard, air pollution, apart from urban areas, is on average low.

As regards soils standards, the Tanzania report provides a very brief statement thus indicating the low priority of the need for such standards. Classification and prioritization of environmental standards is shown in the areas of waste-water, drinking water, air quality and to some extent soils standards. In the area of waste water, standards, methodology and criteria for measurement, and the preferred testing methods are provided. A list of heavy metals which require regulations is also indicated. Like the Kenyan Country Report, the Tanzania report provides a capacity building mechanism. The mechanism has a comprehensive proposal for institutional licensing of polluting sources and integrated approaches to licensing. These mechanisms are intended to eliminate duplication and inefficiency in licensing, inspections and enforcement efforts. A Technical Committee on licensing is also proposed to license polluting sources.

The Tanzania Report also provides proposals for enforcement of environmental standards within and across boarders, that is, East Africa region. It also contains proposals for the use of financial incentives and tools, streamlining of the judicial processes and penalties. Other enforcement mechanisms such as performance bonds, restoration orders, record keeping and inspections are proposed.

In conclusion, the Tanzania report provides a good basis for further development of environmental standards at the national level. Related to this, and at a sub-regional level, the report proposes that a joint institution be established on promulgation and enforcement of environmental standards under the aegis of the East African Tripartite Commission.

Uganda Country Report

Unlike the Kenyan and Tanzanian approaches, Uganda used a different methodology in developing her component of environmental standards under this project. During the Kisumu Workshop on Development of Methodologies and Criteria for Standards, Uganda revealed that she had already embarked on the issue of developing environmental standards. Uganda had used task forces and technical committees. Therefore, under this project, Uganda opted to develop and harmonize soils quality standards only.

The Uganda Country Report on soils management standards was found a priority as it is generally believed that it is a pre-requisite for the long term sustainability of agricultural sector especially on croplands, forests, wetlands and rangeland ecosystems and overall environment management. This is an indicator that Uganda attaches great priority on agricultural productivity.

Unlike the reports from Kenya and Tanzania, the Uganda report did not review existing laws. This activity had been carried out under the National Environment Act Plan (NEAP) Process 1991 - 1995 where it was found that no legally binding standards or guidelines exist on soils standards.

A review of the major environmental problems, the impacts of various uses on the soil, are however, presented. It is seen from the report that Uganda has been conducting soils resource inventories since 1933. In the process, they had developed some working guidelines on soils fertility and productivity and a soils maps were in place, though out-dated. A land-use characteristics of Uganda is also in place.

The report presents draft soils quality standards for:

- agricultural land-use (using rain-fed agriculture);
- special cases (acidic)
- irrigated agriculture
- wetland rice systems under natural flooding
- wetland rice under irrigated systems.

The Uganda report, like that in Kenya and Tanzania provides parameters and methods for determination for chemical and physical standards. Related to the soils quality standards, the report provides soils conservation guidelines for varying topographical areas as seen from the national context. The necessary implementation requirements, frequency of monitoring and cost implication of the soils quality standards are also provided in the report.

Bearing in mind that a certain small but very important population live in urban areas, the report also provides for standards for land-use in urban areas. These standards basically deal with social facilities and waste management standards e.g. landfill management. Under this category, substantive details are provided on the location, inspection process, indirect discharges into landfills, site closure and monitoring of landfills.

In conclusion, the contents of the report from Uganda has since been taken up by the Government and the Environmental Standards (Soils Management Standards) Regulations, 1999 has been drafted. It is expected that by the end of 1999, these draft regulations will become law in Uganda. The soils conservation guidelines and the standards for waste management have been adopted for use by farmers and other appropriate regulatory authorities and stakeholders.

KENYA COUNTRY REPORT

EXECUTIVE SUMMARY

BACKGROUND

Kenya lacks a comprehensive legal and institutional mechanism to address environmental issues related to gaseous emissions, effluent discharge and soil contamination. Fortunately, the Government of Kenya has realised this and efforts have been made to address this short-coming in the last ten years. The National Environment Action Plan (NEAP) Report of 1994, has laid clear objectives and strategies needed in order to control emissions. The need for monitoring of environmental quality and, hence, controlling pollution has been realised. This, however, calls for a sound legal framework.

The draft National Environmental Management and Coordination Bill of 1996, has specified legal and administrative measures, including the incorporation of emission reduction measures, to be addressed at the project planning stage through environmental impact assessment (EIA). The 1996 Sessional Paper on Industrialisation also supports the institution of EIA. The Bill also proposes key areas in which standards and guidelines need to be developed.

The process of harmonising environmental laws and institutional frameworks is a capacity-building effort being undertaken within the UNEP/UNDP/Netherlands/GOK Project on environmental laws and institutions. Within this project is the task of developing and harmonising environmental standards detailed in this document.

The draft environmental standards document recognises the fact that the existing pieces of legislation controlling environmental quality are rather vague and were formulated at a time when scientific information was not clear on causes and effects. This led to the practice of emphasising pollution issues within the context of their global impact rather than their local impacts. It was found practical to develop only standards and guidelines on those environmental quality issues that are of particular concern to Kenyan.

The document is divided into seven chapters. Chapter one explores the broader policy and legislative issues; and the economic and technological driving forces.

Chapter two reviews the various pieces of legislation that address environmental pollution, assessing their scope and limitations. Recommendations are made for improvement in order to guide the institutions responsible for enforcing compliance.

Chapter three puts pollution-based scientific issues into perspective. Recognition is made of the methodologies for assessing pollution risks and hazards. In this context, it is appreciated that risk analysis is a difficult and time consuming exercise for which Kenya is still ill-equipped to undertake.

Emphasis is, therefore, placed on internationally accepted criteria and methodologies applied by international organisations mainly, the World Health Organisation (WHO), the United Nations Environment Programme (UNEP) and the International Standards Organisation (ISO) in developing environmental quality standards and guidelines. The Chapter rationalises the adoption, selection and development of standards on key environment pollutants and the health related contaminants that require control in order to attain a safe environment.

Chapter four gives the justification for prioritising some of the pollutants to be controlled. The key emission sources and the technological, as well as scientific, background is given.

Chapter five outlines the procedure for developing the standards and guidelines. It is noted that environmental quality standards are difficult to enforce. Hence, as a first line of defence, the control of pollutants at source by application of Best Available Technology (BAT) and the employment of clean technologies to minimise emissions is recommended.

In cases where there are diffuse sources as opposed to point sources, and where emission rationalisation is difficult, guidelines are proposed. It was found prudent and practical to adapt the ISO standards and analytical methodologies for the selected pollutants. These form the Draft Kenya Standards (DKS/ISO) which, when adopted, will be the Kenya Standards. The role of monitoring in the effective implementation of the proposed standards as well as the enforcement authorities needed are outlined.

Chapter six suggests a start-up programme for the enforcement of the standards and the institutional capacity-building necessary. The institutional analytical capability currently existing in Kenya is inventoried. The need for a focal co-ordinating institution, such as the National Environment Secretariat, is recognised. Finally, the capacity-building needs in terms of personnel and equipment are proposed.

Chapter seven discusses issues of regional cooperation and gives recommendations on the essential elements in national legislation that require harmonisation for the effective implementation of environmental standards in the Sub-region.

PROPOSED STANDARDS

(a) Air

Air quality standards were found necessary for the work-place and residential facilities; general ambient atmospheres; selected stationary sources; and the transport/mobile sector.

Parameters selected for standardisation include dust, particulate matter and aerosols, sulphur compounds, sulphur dioxide, carbon monoxide, and lead.

(b) Water

Standard vocabulary, methods of sample collection, preservation and testing, and specifications for the following parameters are proposed.

1st Priority

Electrical conductivity, pH, temperature, total dissolved solids, suspended solids, biochemical oxygen demand, chemical oxygen demand, heavy metals, arsenic, selenium, ammonia, detergents, oils and grease, cyanide, sulphide, phenols, nitrates, phosphates, and total coliform organisms.

In order to protect water resources for domestic use and sustenance of aquatic life, specifications for the above variables are proposed for a start for two areas, namely, discharge into public sewers, and discharge into inland waters. The second stage would involve specifying limits for discharge onto land for irrigation purposes, and discharge into marine coastal areas.

2nd Priority

Other pollutants that affect the quality of drinking water and water for irrigation purposes with undesirable consequences on human health and livelihood including residual chlorine; manganese; boron; fluoride; iron; Kjeldahl nitrogen; sulphates; calcium; magnesium and colour.

(c) Soil

The main objectives to be achieved in enforcement of standards on soil involve, making an inventory and classifying soils; establishing a data bank; identifying causes of soil pollution and soil misuse; and continuously monitoring these conditions. The proposed standards include methods for sampling, handling and storage; extraction of trace elements; determination of pH, nutrients, organic matter; and toxicity effects.

COLLABORATION AT NATIONAL LEVEL

The national institutions which were visited were found to have established both formal and informal collaboration for sharing of resources. This is especially so with regard to analytical facilities and, where applicable, during the prosecution

process. Collaboration should be encouraged and supported to facilitate the successful implementation and enforcement of compliance with environmental standards.

REGIONAL COOPERATION

Each participating country in the region should set up a national multi-agency information system. The coordinating agency or hub in each country would then facilitate data and information exchange between itself and other countries. Existing collaboration between research institutions in the region can be utilised to enrich the regional network. A regional committee composed of members from the hubs in each country can be set up to facilitate and enhance regional cooperation.

ACRONYMS

AQS	Air Quality Standard
EHC	Environmental Health Criteria
FA	Factories Act
FAO	Food and Agriculture Organisation
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CO	Carbon Monoxide
CFC	Chlorofluorocarbons
DKS	Draft Kenya Standard
DOHSS	Directorate of Occupational Health and Safety Services
NEAP	National Environment Action Plan
ILO	International Labour Organisation
ISO	International Standards Organisation
IPCS	International Programme on Chemical Safety
IPCC	Intergovernmental Panel on Climate Change
KLRC	Kenya Law Reform Commission
KMD	Kenya Meteorological Department
KARI	Kenya Agricultural Research Institute
MEW	Megawatts Energy
NES	National Environment Secretariat
MWR	Ministry of Water Resources
NEMA	National Environmental Management Authority
TA	Traffic Act
LA	Local Government Act
PH	Public Health Act
PCB	Pesticides Control Board
UNEP	United Nations Environment Programme
UNCETDG	United Nations Committee of Experts on Transport of Dangerous Goods
OECD	Organisation of Economic Cooperation and Development
ODS	Ozone Depleting Substance
UNIDO	United Nations Industrial Development Organisation
ppm	Parts Per Million
WHO	World Health Organisation

TSP	Total Suspended Particulate
VOCs	Volatile Organic Carbons
NMVOCs	Non Methane Volatile Organic Compounds
SS	Suspended Solids

LIST OF TABLES

1.0 INTRODUCTION AND GENERAL CONCEPTS

Achieving good results in environmental management of natural resources is the major objective of world governments today. This involves changing attitudes and behaviour of all citizens to mobilise them to address the serious, complicated and often inter-woven serious threats to the environment. It is in the interest of all to manage all aspects of human development within the context of sustainable development.

All civil societies are governed by agreed rules of behaviour. Some are in the form of laws and others in accepted societal norms. Agenda 21, Chapter 8, recognises the need to build compliance and enforcement capacity as an essential element of environmental management. It requires governments to develop effective national programmes for reviewing and enforcing compliance with national, provincial and local laws on all sectors of environment and developmental activities. Laying strategies for this is a complicated task. It is like a tool-box from which each government selects the most practical and cost-effective tools based on its unique economic, social and political setting.

Over time, Kenya has devised its own tool-box in the form of sectoral laws, bye-laws, regulations and licensing systems which are often implemented in the form of various policy pronouncements. For example, immediately after the Rio Conference on Environment and Development in 1992, the Kenya Government formulated the National Policy Paper on Environment in 1996. It states that the overall policy goal on environment and development will be to achieve economically, socially, and environmentally sustainable national development in all spheres. Prior to that, the National Environment Action Plan (NEAP) Report of 1994 had articulated this same stance.

The NEAP Report states that Kenya's strategy to achieve the policy objective is by providing economic incentives and penalties to encourage sustainable use of natural resources and to minimise pollution by enhancing the harmonisation, implementation and enforcement of laws aimed at the protection of the environment. The strategy involves development of enforceable, effective laws, regulations and standards that are based on sound economic, social, and environmental principles. It recognises of appropriate risk assessments of pollutants incorporating sanctions designed to punish violations, obtain redress, and deter future violations.

It is in this context that the NEAP prioritises the review of all provisions of laws relating to the environment in various statutes with a view to harmonising, updating and strengthening them. One of the major components of these statutes that need policy decision is the establishment and enforcement of environmental standards.

Currently, Kenya's environmental laws are sectoral and address environmental issues such as water pollution, air pollution, and solid waste as such. This division of the environment into separate media, however, fails to recognise that pollutants move from one medium to another. A successful air emissions programme, for example, may only lead to transfer of pollutants to another medium. Successful measures to treat water discharges could simply result in the creation of land-fills causing air contamination and underground water pollution in addition to health and safety hazards.

Enforcement faces serious difficulties. To enforce single sector laws, authorities normally develop a system of single sector enforcement. This results in a situation where those

enforcing air pollution laws are at odds with those enforcing water pollution laws. Compliance with air pollution standards, for example, may lead to reduced air emissions but increased effluent for water authorities to deal with.

The second complication arises from the existing land-use planning practices since development activities are not harmonised to take into consideration multi-media emissions. It is now apparent that environmental pollution (air, soil and water) has become a serious problem in urban and industrial areas, such as Nairobi and Mombasa, and exacerbated by rapid increase in population without proper pollution control measures. With further population increases, areas affected by high levels of pollution will certainly be the areas where human health as well as the natural environment will be adversely affected most, unless effective measures are immediately taken to harmonise population increase, land-use planning and measures to control the resulting pollution.

Environmental pollutants have no boundaries, that is, they cannot be confined to a particular geographical location. There are many national installations and development activities that have cross-border ecological implications. A typical example is the proliferation of the water hyacinth in Lake Victoria due to eutrophication caused by nutrients from land-based sources. There is, therefore, need for international harmonisation of the strategies as well as collaborative efforts especially within the immediate environmental boundaries. In East Africa, Kenya, the renewed and invigorated East African Cooperation mandates member states to harmonise these strategies. Again, NEAP identifies this for strategies to realise those objectives to "enhance cooperation with regional and international environment programmes, treaties, and agreements."

The principal concept for pollution control is control of the emission sources and effective legislation and enforcement or monitoring systems through the traditional command and control method. Where this fails, it is also necessary to provide appropriate incentives and penalties for widespread adoption of these measures. To this end, the following are necessary actions to be taken with regard to the development of environmental standards:

a) formulate a basic framework law for pollution control;

b) establish pollution control enforcement and monitoring systems which are legally recognised and enforced; and,

c) establish single and multi-media emission standards.

1.1 Objectives of Environmental Standards

Laws must be complied with to achieve the desired ends and to ensure compliance, enforcement is necessary. Enforcement of environmental standards is a continuous activity since environmental factors keep changing. Therefore, standards review programmes and activities must be designed to achieve actual changes in conduct of potential polluters. Clear standards against which the conduct of potential polluters can be measured is the necessary prerequisite for effective citizen participation in enforcement efforts in a situation of command and control such as the one that exists in Kenya.

When a potential polluter is provided with specific emission levels, deadlines for compliance, and other definite substantive requirements contained in statutes, regulations or permits, it is easier to identify and prove violation. Such requirements could be particularly effective in Kenya where industry self-monitoring is the norm since the Government's monitoring capacity is still low. The need for clear statutory provisions on standards of conduct cannot be overstated. Random spot checks, compulsory reporting, inter-laboratory calibration and effective incentives and penalties could be driving forces behind comprehensive compliance.

The main reasons why standards are necessary are to:

(a) protect environmental quality and public health;

(b) build and strengthen the credibility of environmental requirements locally, nationally, and regionally;

(C) to ensure fairness to all developers so as to minimise social conflict; and,

(d) reduce costs and liability by making polluters shoulder the short-term costs to attain long-term benefits ecologically and economically.

1.2 Short-comings of the Present Regulations and Standards

The laws and regulations should assist in harmonising national, regional, and local environmental enforcement. The definition of what is environmental and what is not is not adequate enough. To define the regulated community, and define the media and components that should have standards, is essential.

In considering environmental projects, the World Bank defines environmental projects as those undertaken largely for purposes of environmental protection, conservation,

rehabilitation, planning, management, education or institutional strengthening. It is not necessary that a project wholly involves any of the above environmental component, for example, an energy sector development project that contains energy efficiency component. Often a development activity may also have specific environmental components to mitigate or compensate for potential adverse environmental impacts of development activities such as hydro-power plants, irrigation schemes, solid waste incinerators, or major transport infrastructure.

It has been observed that most of the environmental laws under which pollution is controlled in Kenya, are vague. For example, in the case of air pollution, laws simply prohibit "harmful" or "dangerous" pollution, a factor that makes it difficult to have consistent enforcement. Although they serve as a safety valve, experience by field personnel has shown that they would be more effective in the enforcement of the relevant laws, if clear quantitative and qualitative standards were laid out to avoid debates over scientific and policy issues.

The more scientific and policy issues are resolved by statute, regulation or permit, the easier and more cost-effective enforcement becomes. This is not the case now. For example, it is observed that the Water Act (Chapter 372, Laws of Kenya) has emphasised setting end-of-pipe standards, but fails to set water quality standards for rivers, streams and other important water bodies. Unless it is clear what the quality of the stream was before the discharges of pollutants into it, it is difficult to prove that a defendant has violated the water quality standards of that particular water body. The work becomes more complicated with regard to gaseous emissions. Given the complex scientific issues surrounding release, dispersion timing, of gaseous pollutants, among others, catching offenders becomes more difficult.

1.3 Harmonising Standards

The boundaries between the sectors managed by the above tasks are not clearly defined; however, it is necessary to build on the basis of the fact that environmental management has been hitherto sectoral. There are clearly many overlaps, grey areas and outright gaps that render management of the environment fragmentary.

The exercise of harmonising the methodology for developing environmental standards is one of the major tasks of the East Africa Sub-regional Project on Environmental Law and Institutions. Other tasks under the same project include hazardous wastes, environmental impact assessment, forestry, and wildlife legislation. A Eastern Africa Regional Standards Harmonisation Workshop held in Kisumu in September 1996. In that workshop the three East African state on the thematic area of environmental standards agreed on the methodology for developing the standards and the media in which these standards are urgently required. It was agreed that as a first start, the three media of air, water and soil should be given priority.

By prioritising crucial issues in the tasks, common critical environmental issues will be identified and; standards and guidelines for harmonising the management of the issues will also be identified.

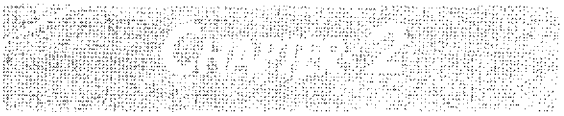
1.4 Prioritization of Sectors and Parameters

The first task of this report was to identify the priority areas relevant for formulating environmental standards and guidelines. The second task was to go into detail to review as many of the existing national standards as possible in those areas. In case no regulations existed, the report proposes for enactment of legislation or promulgation of regulations. The report identifies the key media as air, water and soil. In each medium it was necessary to prioritise the nature and types of pollutants bearing in mind that the number of standards developed must recognise the existing national capacity for enforcement and the available industrial technology.

1. 5 National and Regional Review of the Draft Standards

The report on the development and harmonisation of environmental standards was presented to the National Coordinating Committee (NCC) of the Project, for review, at a workshop held in Machakos on 20th March, 1997. The recommendations of the NCC were incorporated in the report. A regional workshop to discuss issues requiring harmonisation in the development and implementation of standards, was held in Kisumu, from 6th to 7th February, 1998. The recommendations of the Workshop were also incorporated in the report.

The report was further presented at a national consensus building workshop of key stake-holders which was held in Naivasha from 27th to 30th April, 1998. The Workshop recommended, among other things, that standards be developed for other sectors, such as, noise, ionising radiation, and working place environment.



2.0 REVIEW EXISTING STANDARDS AND GUIDELINES

As already stated, the Kenya Government appreciates and is concerned about environmental pollution is articulated in several policy documents. For instance, in the National Environment Action Plan Report of 1994, the Government states that various human activities have led to increased instances of air pollution, liquid and solid wastes. In order to manage these cases, the Government recommends a number of legislative and administrative measures. Some of these include the enactment of comprehensive legislation on control and management of gaseous emissions, review and updating the water standards' regulations as provided under the Public Health Act (Chapter 272) and the Water Act (Cap 372), formulating policies on gaseous emissions, review and enforce legislation to deter water pollution and encourage waste water recycling.

Furthermore, Part V of the draft Environmental Management and Coordination Bill, 1996, provides for the establishment and enforcement of environmental quality standards with respect to water and air emissions. There is to be established a Standards Committee which is required, in consultation with relevant lead agencies, to recommend measures to establish water quality and pollution control standards (clause 24(1)), ambient and occupational air quality standards, emission standards for various sources together with criteria for air pollution control for both mobile and stationary sources (clause 36). The draft Bill has yet to be published and as of now there is no indication as to whether and when this, and the subsequent tabling before parliament for debate, may be done. But the draft Bill is, at least, evidence that the Government is not content with the current status of the quality of the environmental sectors dealt with here.

The issues of environmental management and environmental standards have been addressed by various international inter-governmental and non-governmental organisations in so far as these fall within their statutory mandates. For instance, from its very beginning the International Labour Organisation (ILO) has dealt with the issue of occupational hazards, primarily in order to attempt to eliminate the most dangerous situations and the most serious risks in the working environment. The preparation of international standards for the protection of workers' health has been the principal objective of the ILO's safety and health activities. The ILO has always operated on the principle of the importance of the working environment in which most of the world's population spend the greater part of their lives, cannot be overlooked in any consideration of the total human environment.

The ILO activities in respect of the working environment have generally taken the form of conventions and recommendations which are supposed to provide the basis and guidelines for national actions in the areas addressed by these instruments.

The ILO standards are universal in nature, that is, they are applicable to and capable of attainment by countries with very different social and economic structures and at all stages of industrial development. To attain this objective, standards are made flexible rather than rigid, but must be at the same time meaningful targets for social development. This flexibility is brought about by consideration of the constitutional directive that in framing a convention or recommendation of general application, the ILO Conference must have due regard to those countries in which climatic conditions, the imperfect developments of industrial organisation or other special circumstances make the industrial conditions substantially different and

must suggest the modifications, if any, which it considers may be required to meet the case of such countries (Article 19(3) of the ILO Constitution).

Of particular relevance is the Working Environment (Air pollution, Noise and Vibration) Convention adopted by the ILO General Conference held in June 1977 at Geneva (Convention No. 148). Article one (1) of the Convention makes it applicable "to all branches of economic activity" although paragraph two excludes "particular branches of economic activity in respect of which special problems of a substantial nature arise". The term "all branches of economic activity" has been defined as a comprehensive expression covering all fields, in which members of the economically active population are gainfully employed in the public as well as the private sector (ILO, 1982).

Article 4 of the Convention lays down a general framework for the regulation of matters concerning occupational hazards in the working environment. Paragraph 1 provides that national laws or regulations must be taken for the prevention and control of, and protection against, occupational hazards in the working environment due to air pollution; noise and vibration. Article 8(1) provides that the competent authority of a state party to the Convention must establish criteria for determining the hazards of exposure to air pollution; noise and vibration in the working environment and where appropriate, must specify exposure limits on the basis of these criteria. Under paragraph 3, the criteria and exposure limits must be established, supplemented and revised regularly in the light of current and national and international knowledge and data. This knowledge and data may be provided through research by competent inter-governmental or non-governmental international institutions or standards adopted at the national level by developed countries which set examples widely followed by other countries.

With respect to air pollution, the ILO has publicised the *Occupational Exposure Limits for Airborne Toxic Substances* (ILO, 1980a) which provides a review of the present approach to the problem of exposure limits to noxious substances in the working environment and presents the limits prescribed or recommended in a number of countries. The publication gives specific and detailed explanations with respect to toxic substances, particulate matter and carcinogens.

The ILO has also issued the *Code of Practice on Occupational Exposure to Air-borne Substances Harmful to Health* (ILO, 1980b) which sets objectives to be attained in successive stages in different countries and enterprises according to local circumstances and possibilities. Chapter 3 of the code has detailed provisions on the establishment and application of exposure limits for harmful airborne substances.

The World Health Organisation (WHO) has not only been interested but involved in the control of environmental factors that adversely affect health, such as chemicals and their effects, and other pollutants on air, water, and soil quality standards. Setting environmental guidelines and standards has been one of its main activities, given that the health of the environment has a direct effect on the health of the people.

At the national level, in Kenya, there are several pieces of legislation and statements of policy related to the sectors of the environment covered in this report. The principal legislation that deals with water quality is the Water Act (Chapter 372). The other legislative instruments are the Public Health Act (Chapter 389) and the Penal Code (Chapter 63). These instruments define the polluting activities and specific pollutants subject to control; specify the water bodies and aquatic life for which protection is provided for and the prevention of pollution; empower relevant institutions to establish standards, issue permits, monitor pollution, inspect pollution sources, take remedial measures; and punish activities or processes that cause pollution.

The Water Act and the Water (General) Rules (Legal Notice 374 of 1964) subject the discharge of effluent, trade wastes or solid wastes into or near a water body, to strict controls. Firstly, Section 160(2) of the Act imposes a general prohibition regarding such discharges into or near a body of water. Secondly, Rule 72 of the Water (General) Rules provides that any discharge of effluent into a body of water must conform to a degree of purity that satisfies the Water Apportionment Board. The effluent to be discharged must not contain any matter which might be poisonous or injurious to public health, to livestock or to crops. Any person whose effluent does not comply with this rule is guilty of an offence. The Act does, however, empower the relevant institutions to establish water quality and discharge standards.

The Public Health Act defines nuisances on land and premises and empowers public health authorities to deal with such conditions. Such nuisances include noxious matter or waste-water being discharged into water-courses thereby polluting water sources and supplies meant for domestic purposes or human consumption (Sections 115 and 118). Section 130 of the Act empowers the minister responsible for health to make rules regulating polluting activities, and to require local authorities to enforce them.

The Public Health Act is primarily concerned with domestic water supplies and sources of water used for human consumption, although its regime may be extended to cover rivers, streams, lakes and underground water since these are the basic sources of water for the majority of Kenya's population.

The Merchant Shipping Act focuses on the pollution of coastal and marine waters. The statute does, however, limit itself to discharges of oils from ships within 100 miles of the Kenyan coast. The wider, and perhaps more significant, issue of discharge of other pollutants or the dumping of waste in marine waters is not therefore, addressed by the Act. The Maritime Zones Act (Chapter 371) does, vide Section 5, empower the minister responsible to make regulations concerning the exercise of rights in respect of regulation, control and preservation of the marine environment.

The existing water legislation does not, however, make any provision for the establishment and enforcement of specific water quality standards and discharge guidelines. The legislation merely refers to discharges that are likely to cause pollution or those which may be harmful, injurious or poisonous. Neither the Water Act nor the Public Health Act defines the terms "pollution", "effluent", and "waste", notwithstanding the fact that these are used regularly in the provisions. It is left largely to the judicial process to determine what is "likely to cause water pollution" or is "injurious, harmful, or poisonous" to human and animal health or to plant and fish life. Although Section 126 of the Public Health Act empowers the minister to establish effluent discharge standards, this power has not been exercised, with the result that there are no such standards.

Section 191 of the Penal Code criminalises the voluntary corruption or fouling of water of any public spring or reservoir "so as to render it less fit for the purpose for which it is ordinarily used", without provision of any yard-stick for measuring such corruption or fouling. Currently, the Government uses the discharge guidelines that have been adapted from the British Royal Commission Standards on the Prevention of River Pollution, and the WHO Guidelines although these have not, however, been published as the official guidelines.

With respect to air pollution, it is noted that, the legal machinery for dealing with the causes is as fragmented as that for water. The control and prevention of air pollution is dealt with under the Public Health Act, the Traffic Act (Chapter 403), the Factories Act (Chapter 514), and the Penal Code. Among the nuisances specified under Section 118 of the Public Health Act, two are relevant for the control and prevention of air pollution. Sub-section 1(o) and (q) provides that factories or trade premises causing smells or effluvia which are offensive or injurious or dangerous to health, are nuisances to be dealt with as provided for under the Act. Until 1990, these were the only provisions for dealing with atmospheric pollution arising from industrial establishments. They neither define the parameters of air quality nor establish enforceable emission standards. Furthermore, there is no provision requiring the installation of treatment works to reduce or eliminate the adverse impact of emissions on public health or the environment.

In the same way, the Traffic Rules (Legal Notice 1902 of 1953), made under Section 119 of the Traffic Act, prohibit the "emission of smoke or visible vapour" from a motor vehicle, without laying down specific emission standards.

In 1990, the coverage of the Factories Act, which regulates safety, health, and welfare conditions within the factory working environment, was extended so as to cover the issue of the impact of industrial production on the general environment. This was done by the Factories (Amendment) Act, 1990 (Act No. 31 of 1990). Section 17 of the 1990 Act, amending Section 51 of the principle Act, now requires that dust, fumes or impurities shall not be emitted into the atmosphere without first undergoing appropriate treatment to prevent air pollution or other ill-effect to life and property. This requirement applies equally to exhaust gases from internal combustion engines used in factories. Besides, Section 44 of the principle Act, as amended, together with the Seventh Schedule include "the escape or leakage of toxic gases, fumes, liquid or substances injurious to health" among the "dangerous occurrences" requiring notification to the Chief Inspector of Factories. The Act, however, does not establish any air quality standards or emissions criteria for pollutants and although section 20 of the 1990 Act empowers the Chief Inspector of Factories to establish standards and develop criteria, this is restricted to safety, health and welfare in the factories and other places of work and does not address the wider issue of emission and quality standards with respect to the general environment. In essence the amendment law neither defines air quality criteria nor sets emission standards for the guidance of the law enforcement personnel.

Section 192 of the Penal Code criminalises voluntary conduct that vitiates the atmosphere in any place, "so as to make it noxious to the health of persons in general dwelling or carrying on business in the neighbourhood or passing along a public highway". There is no specification of quantities of, for instance, particulate matter that may trigger liability under the law.

Kenya being an agricultural country, the quality of its soils is critical to its economic growth. The soils are the foundation of all agricultural activities. There exist several pieces of legislation related to soil and the maintenance of its quality. Of these, the Agriculture Act (Chapter 318), the Land Planning Act (Chapter 303), and the Fertilizers and Animal Foodstuffs Act (Chapter 345), are of direct relevance.

The main objectives of the Agriculture Act are to promote and sustain agricultural production, provide for the conservation of the soil and its fertility and stimulate the development of agricultural land in accordance with accepted practices of good land management and husbandry. The Act vests powers in the minister responsible for agriculture concerning the preservation, utilisation and development of agricultural land. Regulations made under the Act prohibit certain land use practices that are incompatible with the stated objective of good husbandry, such as the clearing of vegetation and the depasturing of grazing areas, and require the adoption of conservation measures such as the planting of trees or terracing to prevent soil erosion. Besides, the Agriculture (Land Preservation) Rules (Legal Notice 352 of 1963) empower the Director of Agriculture to issue land preservation orders to land owners requiring them to undertake land conservation measures, or prohibiting activities incompatible with good land management.

The Land Planning Act establishes the legal and institutional framework for land-use planning and zoning in the country. It provides for both the elaboration of land-use plans and development controls. The Act establishes two institutions for land-use planning purposes, namely, an "interim planning authority" and the Central Authority. The minister is empowered to constitute a local authority into an interim planning authority where an area plan or town plan had been approved for the local authority area. An interim planning authority is empowered to consider and determine planning applications submitted to it under the statute.

The Central Authority is an inter-ministerial authority composed of public officials from the ministries responsible for local government, economic planning, agriculture, public works, health, and the Town Planning Advisor. The Central Authority is chaired by the Commissioner of Lands and is the planning authority for all areas where the minister has not constituted an interim planning authority. In considering planning applications for such areas, however, the Central Authority is required to consult the local authority within whose jurisdiction the land, the subject of the planning application, is situated.

The Fertilizers and Animal Foodstuffs Act regulates the importation, manufacture and sale of agricultural fertilizers and animal foodstuffs and substances of animal origin intended for the manufacture of such fertilizers and foodstuffs. Under Section 3 of the Act, no person is allowed to import, manufacture, compound, mix or sell any fertilizer or animal foodstuff other than an approved animal foodstuff. Under Section 4, no person is allowed to import any fertilizer or animal foodstuff, which contains bone or any other substance derived from an animal carcass, or bones or any other substance derived from an animal carcass for the purpose of manufacturing any fertilizer or animal foodstuff unless he produces certification from a designated official of the country of origin to the effect that such bone or substance has been effectively and completely sterilized and is free from such pathogenic organisms as may be prescribed. Section 19 empowers the Minister to promulgate rules, standards of composition, efficacy, fineness and purity of fertilizers or animal foodstuffs. The purpose here is to prevent the importation and sale of fertilizers that may pollute or adulterate the soils.

The Pest Control Products Act (Chapter 346) also has provisions whose effect is to prevent soil pollution. The Act regulates the importation, exportation, manufacture, distribution and use of products used for the control of pests and of the organic function of plants and animals. Section 3 of the Act prohibits the manufacture, packaging, storage, display, distribution, use or advertisement of any pest control product except in accordance with the regulations made under the Act. Also prohibited is the packaging, labelling or advertisement of any pest control product in a manner that is false, misleading or deceptive or is likely to create an erroneous impression regarding its character, value, quality, composition, merit or safety. Section 4 prohibits the importation into, or sale in, Kenya of any pest control product unless that product has been registered, packaged and labelled in accordance with the regulations made under the Act and conforms to the standards prescribed in those regulations.

Besides, no person is allowed to export or re-export out of Kenya any pest control product unless he has complied with the requirements specified in the regulations. There are then regulations with respect to the registration of the products, the licensing of premises for the manufacture, packaging, sale or storage of the products, labelling and advertisement of the products, classification, and the importation and exportation of the products. These provisions are aimed basically at protecting the consumer from the public health and environmental hazards associated with the use and handling of pest control products. Besides, since pest control products end up in

the soil in one way or another, their proper handling and usage will ensure the protection of soil from their chemical or toxic effects.

2.1 Water Quality Guidelines and Standards

It is apparent that although there exist pieces of legislation regarding the protection of the areas under review, there exists no national environmental standards for the protection of these areas. With respect to water pollution control, standards may be applied in two areas, namely, the receiving water body or the effluent depending on whether :

a) whether the stream quality is considered paramount, that is, in-stream, ambient or receiving water standards; or,

b) the effluent quality is considered paramount, that is, effluent discharge standards.

2.1.1 Ambient or In-Stream Standards

In-stream standards refer to rivers, lakes, estuaries or ground-water and reflect the assimilative capacity of the water body receiving the effluent. Their purpose is to preserve the aquatic environment at a certain specified minimum quality. The standards impose the joint responsibility on all polluters to maintain the prescribed stream quality. This implies that the various water resources have to be classified or graded leading to the establishment of different stream standards. Maintenance of such standards would require similar industries discharging at different stretches of a river to treat their effluent to different degrees based on the assimilative capacity of the stream and subsequent use of the water down-stream of the discharge point.

Ambient or in-stream standards reflect tolerance limits for inland surface waters used as sources of water for public water supply, irrigation, fish culture, and bathing, among other uses. The Indian Standard, for example, prescribes the tolerance limits for inland surface waters subject to pollution which are used for the above purposes. The standards are intended to help local authorities in deciding on restrictions that may be required on the discharge of industrial and sewage effluent into inland surface waters.

Ambient stream standards are difficult to enforce due to:

a) the contribution of diffuse or non-point sources of pollution;

b) equity problems - similar industries or municipalities located at different reaches of the stream are frequently required to have different levels of treatment; and,

c) complexity of the surveillance tasks by the responsible administrative agency. In case of violation in complex river systems, it becomes a difficult task to fix the blame on the responsible polluter.

2.1.2 Effluent Discharge Standards

Effluent standards encompass effluents from municipal, industrial, and agricultural sources. They apply to the material being discharged to the receiving water and do not consider the most economic use of the assimilative capacity of streams (Ciaccio, 1972). These standards prescribe the quality of the effluent to be discharged into a water body or public sewer by restricting the quantity of pollutants in the effluent or setting the desired degree of treatment. This implies that similar industries need to maintain a similar standard; however, different industries with different effluent characteristics discharging into the same water body or public sewer have different effluent discharge standards, that is, industry-specific standards. The effluent standards are considered simple and easy to administer.

2.1.3 Status of Water Pollution Control Guidelines and Standards in Kenya

In Kenya, there are presently no effluent discharge standards. There are, however, guidelines which are categorised depending on whether the effluent are discharged directly into a water body (in which case a full treatment is necessary), or a public sewer where pre-treatment is required. The generalised effluent discharge guidelines or interim pollution control guidelines in use **(Table 2.1)** have been adopted from the British Royal Commission Standards on the Prevention of River Pollution, and the World Health Organisation (WHO) Guidelines. The main condition is that the receiving water body must have a dilution capacity of not less than 1:10.

Table 2.1: Generalized Effluent Discharge Standard

Parameter	Limits
pH	6.0 -9.0
BOD (5 days at 20°C)	20mg/l
COD	50mg/l
Suspended Solids	30mg/l
Cyanide (Soluble)	0.1mg/l
Sulphide	2 mg/l
Nitrates	30 mg/l
Heavy Metal (combined)	1.0mg/l

Source: Ministry Water Resources.

The effluent quality guidelines for discharge into the aquatic environment and into public sewers are presented in **Table 2.2** and **Table 2.3** respectively. It should be noted that the guidelines issued by the Ministry of Water Resources (MWR) have been varied at times for reasons not clearly documented.

In some instances, however, it has been found necessary to vary the guidelines and issue factory specific ones, depending on the site of the industry, the quantity and nature of the effluent, the assimilative capacity of the stream and water uses. Thus, the present guidelines for effluent discharge in Kenya are actually a combination of both stream and effluent discharge guidelines. **Table 2.4** and **Table 2.5** give some examples of such individual effluent discharge guidelines. Effluent discharge standards for textile industries in other countries have been included in **Table 2.5** for comparison.

Table 2.2: Existing Standards for Discharge of Effluents into Aquatic Environment

Parameter	Limits	Remarks
pH	6.0 - 9.0	
BOD (5 Days at 20°C)	20 mgO_2/l0	
COD	50 mgO_2/l	
Suspended solids	30 mg/l	
Total phenols	0.001 mg/l	(2.0 mg/l in some cases)
Copper	3 mg/l	(0.05 mg/l in some cases)
Zinc	0.5 mg/l	
Sulphates	250 mg/l	(500 mg/l in some cases)
Dissolved iron	10 mg/	
Dissolved manganese	10 mg/l	(0.1 mg/l in some cases)
Chromium (Total)	2 mg/l	
Chromium (Hexavalent)	0.5 mg/l	
Chloride	200 mg/l	(1000 mg/l) in some cases)
Fluoride	2.0 mg/l	
Free ammonia	0.2 mg/l	
Coliform Bacteria	300 mg/100ml	(1000/100ml in some cases)
Colour (Hazen units)	5	(Not objectionable to the eye)
Dyes	Nil	
Sulphide	0.1 mg/l	
Cadmium	0.1 mg/l	(0.05 mg/l in some cases)
Cyanide	0.1 mg/l	
Organic phosphorus	1.0 mg/l	
Nickel	1.0 mg/l	
Selenium	0.05 mg/l	
Barium	2.0 mg/l	
Lead	1.0 mg/l	
Arsenic	0.02 mg/l	
Total mercury	0.005 mg/l	
Alkyl mercury	Not detectable	(0.001 mg/l in some cases)
Polychlorinated biphenyls,	0.003 mg/l	
Smell	Not objectional to the nose	
Toxic substances	Nil	
Pesticides	Nil	(0.05 mg/l in some cases)
Oils and grease	Nil	
Degreasing solvents	Nil	
Calcium carbide	Nil	
Chloroform	Nil	
Condensing water	Nil	
Inflammable solvents	Nil	
Temperature	30°C	(±2°C of ambient)
Dissolved solids (total	1200 mg/l	
n-Hexane extract	30 mg/l	

Table 2.3: Existing Standards for Discharge of Effluents into Sewers

Parameter	Limit	Remarks
pH	6.0-9.0	
BOD (5-day at 20°C)	500 mg/l	
COD	1000 mg/l	
Settleable solids	1.0 mg/l	
Total suspended solids	500 mg/l	
Total non-volatile dissolved solids	100 mg/l	(2000 in some cases)
Smell	Not objectionable to the nose	
Toxicity	Non-toxic	
Detergents	30 mg/l	(15 mg/l in some cases)
Soaping oils & Fats	50 mg/l	
Phenols	10 mg/l	
Hydrocarbons (cyclic)	5 mg/l	
Silver (Ag)	2 mg/l	
Arsenic As)	0.2 mg/l	
Barium Ba)	10.0 mg/l	
Cadmium (Cd)	0.5 mg/l	
Chlorite (ClO_2)	2 mg/l	
Cyanide (CN-)	0.5 mg/l	
Cyanide (CN) Total	2.0 mg/l	
Cobalt (Co)	1.0 mg/l	
Chromium (Vl)	0.5 mg/l	(0.05 mg/l in some cases)
Chromium (total)	1.0 mg/l	
Copper (Cu)	1.0 mg/l	
Mercury (Hg)	0.05 mg/l	(0.01 mg/l in some cases)
Ammonium/ammonia (NH_{+4}/NH_3)	2.0mg/l	
Nickel (Ni)	3 mg/l	(1.0 mg/l in some cases)
Nitrite (NO_2-N)	2.0 mg/l	
Nitrate (NO_3-N)	20.0 mg/l	
Lead (Pb)	1.0 mg/l	
Phosphate-(PO_4-P)	30 mg/l	
Sulphide (S)	2 mg/l	
Selenium (Se)	0.2 mg/l	
Tin (Sn)	5 mg/l	
Sulphite (SO_3)	50 mg/l	
Sulphate (SO_4)	1000 mg/l	
Zinc (Zn)	5 mg/l	
Total non-ferrous metals	10 mg/l	
Chlorides (Cl)	1000 mg/l	
Oils and grease	10 mg/l	(Nil in some cases)

In addition, no person shall discharge into the sewer any of the following substances:

(a) Calcium carbide
(b) Chloroform
(c) Condensing water
(d) Degreasing solvents of mono-di-trichloroethylene type
(e) Inflammable solvents
(f) Radioactive residues

Table 2.4 Examples of Industry-specific Effluent Discharge "Standards" issued to some Industries in Kenya.

Parameter	Limit Concentration (mg/l)		
	Pan Paper (1)	**Kenya Breweries (2)**	**Kenya Canners (3)**
pH	6.0	6.0 - 9.0	6.0 - 9.0
BOD(5 days at 20_C)	20	20	20
COD	50	-	-
Suspended Solids	30	30	30
Free Ammonia	2.0	-	-
Permanganate Value (4 hr)	1.0	-	-
Heavy Metals (excluding Fe and Hg)	1.0	Nil	Nil
Mercury, Hg	0.005	Nil	Nil
Iron, Fe	0.05	-	-
Phenols	0.005	-	-
Free Chlorine	0.1	-	-
Organic Chlorine	0.005	Nil	Nil
Oils and Grease	No trace	Nil	Nil
Temperature	± 2°C of ambient	24°C	±2°C of ambient
Total Coliforms	-	1000/100mls	1000/100mls

Note:

(1) Pan African Paper Mills, Webuye, discharges into Nzoia river.

(2) Kenya Breweries Ltd, discharges into Ruaraka river. The Nairobi City Council has also issued standards for discharge into the sewers to this factory.

(3) Kenya Canners Ltd, Thika, discharges into Thika river

Table 2.5: Effluent discharge standards issued to some textile industries in Kenya. (The standards for other countries are included for comparison)

Parameters	Limit to Water Body (Concentration in mg/l)					
	Kenya (1)	Germany (2)	Australia (3)	India (4)	Malaysia (5)	Brazil (6)
pH	6.0-9.0	-	6.0-9.0	5.5-9.0	6 - 9	5 - 9
SS mg/l	30	40	60	100	50	-
Turbidity, NTU	-	-	50	-	-	-
Floatable matter	-	-	Nil	-	-	Nil
Oil and Grease	no trace	-	-	10	not detectable	-
Settleable Solids mg/l	-	0.3	Lowest possible	-	-	0.5
BOD_5 (at 20°C)	20	40	40	150	20	20
Arsenic	**	-	0.5	-	0.05	0.5
Cadmium	**	-	0.l0	-	0.01	0.2
Chromium	**	2	0.30	2	0.2 (0.005)	0.5 (2.0)
Copper	**	1	0.20	-	0.2	1.0
Iron	**	-	5.0	-	1	15 (soluble)
Lead	**	-	0.l0	-	0.1	0.5
Manganese	**	-	0.5	-	0.2	1.0 (soluble)
Mercury	**	-	0.005	-	0.005	0.01
Nickel	*	-	0.50	-	0.2	2.0
Zinc	**	3	0.50	-	1	5.0
Residual Chlorine	-	0.3	1.0	-	1	-
Toxicity to fish	10*	4*	-	-	-	-
Temperature °C	25	-	-	-	40	40
Ammonium	5	5	-	-	-	5.0
Cyanide	-	-	-	-	0.05	0.2
Phenols	0.1	-	-	5	0.001	0.05
Fluorine	-	-	-	-	-	-
Selenium	-	-	0	-	-	0.05
Sulphate	-	-	-	-	-	1.0
Sulphide	-	0.1	-	2	0.5	-
COD	100	280	-	-	50	-

Note:

* Effluent not to be toxic to fish at the specified dilution rate

** Heavy metals combined not to exceed 0.1 mg/l

(1) Departmental records, MWR

(2)-(6) See References Nos.1, 31, 21, 32 and 19 respectively.

2.1.4 Attempts at Developing Effluent Discharge Standards

As early as 1984, the Sewerage Department of the then Ministry of Water Development, proposed effluent discharge limits for industries discharging into public sewers and effluent treatment plants discharging into streams. The limits for direct discharge into streams were adopted from European standards while those for discharge into public sewers were adapted from Indian standards. The proposed limits were meant to be used to advise local authorities throughout the country on pollution control; however, the idea was abandoned because "National Effluent Discharge Standards were not considered practicable at the time and factory-specific discharge aliens were preferred".

Such industry-specific standards were based on a dilution capacity of 1:10 in the receiving stream. At lower dilutions the standards to be complied with would be more rigid. The "standards" were not gazetted and therefore, had no legal basis and as such were merely technical guidelines.

Later in 1990, discharge standards for effluents into public sewers were proposed (**Table 2.6**). The Indian standards were used as the basis for drawing the standards. The proposed Kenya Standard was more stringent in certain aspects such as suspended solids, temperature, oil and grease; ammonia nitrogen, calcium, chromium, copper, selenium and sulphate, but less stringent on others, namely, dissolved solids, BOD, arsenic, mercury, lead, nickel, chloride and phenols.

In addition, the proposed Kenya Standard gave specifications for parameters not specified in the Indian Standard.

These included particle size of suspended solids, total residual chlorine, total kjedahl nitrogen, free ammonia, COD, phosphates, detergents, phenols and chlorinated hydrocarbons. Apparently, no justification was documented for the variation from the Indian standard.

2.1.5 Limitation of the Existing Generalized Standards

a) The limits are based on the quality of United Kingdom rivers used as receiving waters for effluents in the United Kingdom.

b) Assumption that the receiving water has a BOD less than 2 mg/l and that the effluent inflow will be diluted 8- to 10-fold by the receiving water. The basis of dilution does not take the technology into consideration. Moreover, hydrological changes due to anthropogenic factors have reduced the dilution capacity of some streams.

c) The standards are simplistic, giving only upper limits and may therefore, not be stringent enough as Kenya gears to industrialise by the year 2020.

d) The standards are not gazetted, and therefore, not enforceable by law

Table 2.6 Proposed Effluent Discharge Standards for Public Sewers in Kenya (1990) Compared to Indian Standards

Parameter	Indian Standard	Proposed Kenya Standards
Colour	-	
Suspended solid mg/1, max	600	250-400
Particles size of suspended solids	-	850 µm
Dissolved solids (inorganic) mg/l, max	2100	3,000
Temperature, °C max	45 at the point of discharge	Not more than 35°c
pH value	5.5 to 9.0	5.5 to 9.0
Oil and grease, mg/l max	20	10.0
Total residual chlorine, mg/l max	-	Nil
Ammoniacal Nitrogen (as N) mg/l max	50	20
Total kjeldahl nitrogen as N), mg/l max	-	Nil
Free ammonia (as NH_3) mg/l max.	-	10.0
Biochemical oxygen demand (5 days at 20°C), max	350	400-500
Chemical oxygen demand, mg/l max	-	30-100
arsenic (as As)mg/l max	0.2	1
Mercury as (Hg) mg/l max	0.01	0.05
Lead (as pb) mg/1 max	1	2.0
Cadmium (as Cd), mg/1 max	1	0.5
Hexavalent chromium (as Cr $+^6$) mg/1	2	0.05
Total chromium (as Cr) mg/1 max	2	3.0
Copper (as Cu), mg/1 max	3	2.0
Zinc (as Zn), mg/1 max	15	5
Selenium, (as Se), mg/1 max	0.05	1.0
Nickel (as Ni), mg/1 max	3	3
Boron (as B), mg/1 max	2	2
Residual sodium carbonate, mg/1 max	-	-
Percent sodium max	60	60
Cyanide (as CN) mg/1, max	2.0	6.0-10
Chloride (as Cl) mg/1, max	1000	1000
Fluoride (as F), mg/1, max	15	15
Dissolved phosphate (as P, mg/1 max	-	30
Sulphate (as SO_4) mg/1 max	1000	100
Sulphide (as S) mg/1, max	-	2
Pesticides	Absent	
Phenolic compounds (as $C_6 H_5 OH$) mg/1, max	5	None
Radioactive materials	10^{-6}	10^{-6}
a) Alpha emitters, mc/ml max	10^{-7}	10^{-7}
b) Beta emitters	10^{-6}	
Detergents		15 mg/l
Phenols		15mg/l
Chlorinated Hydrocarbons		5mg/l

2.1.6 Implementation and Enforcement of Water "Standards"

The exploitation of water resources is controlled through a permitting system by the Water Apportionment Board in exercise of the provisions in the Water Act, Cap 372 which stipulate that, "a permit shall be required in all cases of proposed diversion, abstraction, obstruction and use of water". In the case of water abstraction for industrial use, the applicant is required to outline the methods to be used to treat the effluent before discharge. In this regard, the applicant is required to submit designs of the effluent treatment facility for approval by the Director of Water Development. The treatment facility's performance is evaluated on the basis of the effluent discharge guidelines issued on application for a water abstraction permit.

The Water Quality and Pollution Control Division of the MWR has a sampling programme for industrial effluents and a water quality monitoring programme to check compliance to the set guidelines. Random inspections of industries are also carried out. Those who violate the standards are advised on appropriate remedial action. Persistent violation, however, leads to prosecution. Examples of industries prosecuted for violating various sections of the Water Act include the East African Sugar Industries, Muhoroni; Agro-chemical and Food Company, Muhoroni; Kenya Matches Limited, Kisumu; Pan African Paper Mills, Webuye; Gnanjivan Galvanizing Wire Mills, Ruiru; Kenya Canners, Thika; and, several coffee and sugar industries.

Implementation of standards has been constrained by lack of baseline data for the review of issued guidelines. Therefore, standards or guidelines once issued to an industry are not reviewed to take cognisance of the changing environmental conditions.

Enforcement, too, has been constrained by inadequate penalties which are non-deterrent, lack of incentives for cleaner production, standard testing methods, accreditation of water testing laboratories, and lack of continuous monitoring due to logistical problems including finance and equipment. Moreover, due to the fact that the interim pollution limits are not gazetted, legal enforcement has been difficult. Therefore, the advisory and persuasive (negotiation) approach has been predominant. Cases of non-compliance by industry can be attributed to low awareness, lack of incentives, outright dishonesty, political interference, and lack of motivation for enforcement.

Despite the difficulties encountered, some success has been achieved with industries such as Mountex and Rivatex (textile), Leather Industries of Thika (tannery) and Mumias sugar factory, among others, meeting issued guidelines. In some cases, more stringent standards are being complied with especially where corporate policies give due attention to environmental protection.

2.2 Air Quality Regulations

2.2.1 Environmental Policy and Air Quality

The Kenya Policy Paper on Environment appreciates that air quality has been taken for granted for too long. It proposes a programme of action in which the government will step up efforts to control air pollution through existing, new legislation and other appropriate means.

The proposed programme includes arresting the problem at source by setting up emission standards, using incentives and disincentives for pollution control, and enacting a Clean Air Act.

JUSTIFICATION FOR A CLEAN AIR ACT

There is now a widely shared opinion that the legislative, institutional, regulatory and economic aspects of the prevention and control of environmental impact must be rationalised to offer Central Government regulators as well as local regulators such as the provincial administration, the District Development Committees, the Local Authorities, the judiciary and the "wananchi" at large, a sure and coherent framework from which to seek redress in case of pollution. On this basis, the regulators and the regulated can define site specific degree of flexibility and choose viable technical options since a trade off is necessary appreciating that certain levels of pollution are the price for development. Environmental restraints and counter actions which at times are unnecessary could thus, be avoided.

In most countries where there is a legal provision for controlling air pollution, a rule of the thumb applied is that air emissions must not disturb persons, jeopardise public health and safety or harm agriculture, buildings and monuments. In Kenya, few provisions explicitly control air pollution. Many of the public complaints on air are related to disturbance of people by such nuisances such as odours, effects on public health and deterioration of buildings, usually corrugated iron sheets and other physical structures.

Seeking redress on suspected air pollution has been difficult as the existing regulations that attempt to control air

pollution do not specifically quantify "air pollutant" or the control level to be achieved. Standards are therefore, necessary to address the areas of quantifying air quality criteria, and selection of control measures intended to ensure compliance with these criteria.

2.2.2 Current Laws and Regulations

The following are the major existing pieces of legislation that address air pollution:.

1. Penal Code, Cap 63
2. Chiefs Authority Act, Cap 128
3. The Public Health Act, Cap 252
4. The Local government Act, Cap 265
5. The Mining Act, Cap 306
6. The Traffic Act, Cap 365
7. The Factories Act, Cap 514
8. Grassfires Act, Cap 327

The Chief's Act is currently under review and is not discussed here. The Grassfire Act appreciates that grass-fires are a major source of air pollution episodes and with the exception of controlling grass-fires, standards may not be applicable and therefore, this act will also not be discussed in detail here. Other Acts could be amended to focus more on air pollution and are discussed here below:

(i) The Penal Code. Cap 63

The Penal Code is one of the oldest statutes on air quality management. Enacted in 1930, Part XVII contains a chapter on " Offences Against Health and Convenience" in Sections 191-193. The Code strictly prohibits releasing of foul air which affects the health of other persons

Section 192 states:

> " *any person who voluntarily vitiates the atmosphere in any place, in any place, so far as to make it noxious to the health of persons in general dwelling or carrying business in the neighbourhood or passing along public way is guilty of a misdemeanour*

The punishment for a misdemeanour is Imprisonment not exceeding two years with no option of a fine.

Section 193 prohibits fouling of air by industrialists and manufacturers, among others, and provides:

"any person who for the purposes of a trade or otherwise makes loud noise or offensive or unwholesome smells in such places and circumstances as to annoy any considerable number of persons in the exercise of their rights, commits an offence and is liable to be punished for a common nuisance"

Punishment for a common nuisance is imprisonment not exceeding 1 year- no option of a fine.

The Penal Code has thus best intentions for controlling pollution for industries; unfortunately, however, the terms used such as " foul air" or smells are subjective and difficult to prove in a court of law. In fact "offensive" smells or "unwholesome" smells are not defined

"The smells to constitute an offence under this law must affect a considerable number of persons carrying a business in the neighbourhood"

What is considered a considerable number is a matter of mathematics. It is recommended that a criteria be devised for "offensive smells " in measurable quantities such as public complaints, pollution indicators such as accelerated corrosion of iron sheets or other physical manifestations.

ii) Factories Act, Cap 514

The Factories Act, Cap 514, revised in 1972, is an Act of Parliament to make provision for the health, safety and welfare of person employed in factories and other places of work. It was amended in 1990.

The 1990 Amendment prohibits emission of "dust", fumes, or impurities into the atmosphere without undergoing treatment to prevent air pollution or other ill effects to life and property". This amendment now also includes any stationary combustion engine from discharging exhausts without treatment/or emission reduction to prevent air pollution or any ill effect of life and property.

In addition, the following Sections are important to air pollution control:

a) Part IV on Health General Provisions - under section 19 requires enforcement of sanitary convenience, by local authorities. This apparently is to reduce nuisance odours associated with unhygienic sanitary facilities.

b) Part V on Air Receivers - provides for taking of precautions in places where dangerous fumes are likely to occur.

c) Section 39: Precaution with respect to explosive or inflammable dust or gas;

d) Part VII: Health, Safety and Welfare - Special Provisions and Rules;

e) Section 57:Removal of dust or fumes; and ,

f) Power to take samples from polluting sources.

It is apparent from the definition in Section 51 on the issue of the terms "dust" or "fume" is very subjective as it is left to the inspector to determine whether the dust or fumes are injurious to the people working there in particular or to the environment in general. The inspector may not be equipped with criteria for judging this.

It further requires that exhaust appliances be provided and maintained as near as possible to the point of origin of the dust or fumes or other impurity so as to prevent it entering the air of any workroom. This of course immediately exempts air pollution sources from non-point sources in areas such as waste disposal sites, waste treatment sites, and their immediate environment.

The following recommendations are made to address this:

1) Guidelines on design of chimneys and stacks be developed.

2) Specification of what constitutes " dust" and what constitutes "gases" which are health related be defined.

3) A comprehensive list of poisonous or harmful gases be developed.

4) Monitoring regime for dust and particulate be regularly instituted.

(iii) The Traffic Act Cap 403 (Rev. 1978)

The Traffic Act, Cap 403, Section 51 requires motor vehicles to use proper fuel which may be construed to mean reduction of pollution. Specific provisions are included in the Traffic Act requiring that every vehicle is so constructed and maintained and used in such a way that it does not emit smoke. Section 51 states:

> *"No fuel shall be used in any motor vehicle except that specified in the vehicle licence in respect of such a vehicle or in the case of a motor vehicle, the motor unit of which is a compression ignition engine, light amber mineral fuel oil"*

This act leaves room to adulterate vehicle fuels as it does not specify the additives as in the case of leaded petrol. It is difficult to verify fuels by traffic police except in the Vehicle Inspection Units (VIU) which in any case, is only a requirement for commercial vehicles. Even at these VIUs, the inspection is visual in relation to smoke emissions.

Section 55 states:

> *"No vehicle shall be used on a road unless such a vehicle and all parts or equipment thereof including lights and tires comply with the requirements of this Act, and such parts and equipment shall at all times be maintained in such a condition that the driving of the vehicle is not likely to be a danger to other users"*

On the face of it, this Section does not specifically control pollution.

This is elaborated in Section 117. Minor traffic offences are formulated under Section 55. They include:

- failure to carry an efficient silencer. Although the need for a silencer is to control noise, a vehicle without a silencer does not allow for complete fuel combustion which in itself increases the amount of hydrocarbons emitted as air pollutants; and,

- using a vehicle emitting smoke or visible vapour.

It is important for fuel efficiency to have an effective exhaust cleaning equipment for not only safe driving but also for the environment.

Rule 81 is an interesting one. It relates to filling with petrol while the engine is running. This is to reduce fire incidence but would also minimise release of hydrocarbons. Failure to comply is punishable by a statutory maximum penalty of Ksh. 100. This rule is rarely enforced.

The following recommendations are made to address this anomaly since this is the most appropriate act to control emissions from mobile sources its review is necessary in the following areas:

(a) incorporation of standards for lead in petrol; and,

(b) guidelines for emissions from all vehicles in terms of Volatile Organic Carbons (VOCs) and hydrocarbons.

(iv) The Local Government Act, Cap 265

The Local Government Act is concerned with a wide range of matters that affect day to day activities of individuals and organisations. Section 163, Sub-section (e) empowers municipal councils, town councils, and urban councils to control or prohibit all businesses, factories and workshops which by reason of smoke, fumes, chemicals, gases, dust, smell, noise or vibration, may be a source of danger or annoyance to the neighbourhood and to prescribe the conditions subject to which business, factories, and workshops shall be carried on.

In this regard, the act requires owners of those businesses to:

> *"control, prohibit all business, factories and workshops which by reason of smoke, fumes, chemical gases, dust, smells, noise, vibration or others may cause to be or become a source of danger, discomfort or annoyance to the neighbourhood and to prescribe the conditions subject to which such businesses, factories and workshops shall be carried on"*

The mechanism used by the local authorities to achieve the above objective is by:

(a) prescribing the necessary bye-laws, rules and enforcing them; and,

(b) refusal, cancellation or withdrawal of licences where:

the method adopted by the licensee or applicant for preventing offensive vapours, gases or smells arising from works or trade to which such a license applies is not satisfactory to the local authority.

The recommendations made to address this are:

(i) formulate regulations for the procedure to be followed in determining non-compliance; and,

(ii) ensure effective licensing procedures that may incorporate a requirement for environmental impact assessment.

(vi) The Public Health Act, Cap 252

This Act is one of the most widely implemented pieces of legislation on health and safety. The main institutions of enforcement are the Public Health Department of the Ministry of Health and the local authority. The ministry has personnel at local authority, locational and even sub-location levels. The most relevant parts as far as air pollution is concerned is in Part IX on Sanitation and Housing. This Act is widely applicable since it is not restrictive as the Factories Act and actually, Section 118 (n) makes factories or other trade premises all inclusive, which means that in the absence of factory inspectors, public health officers can actually step in to stop pollution.

Section 115 prohibits nuisances and gives local authorities the mandate to prevent the nuisances. Local authorities in turn formulate local authorities bye-laws; however, few of the authorities have capacity to investigate pollution incidence.

A nuisance is defined in Section 118 (n) as any smell arising from any drainage privy, water closet, earth closet. These could be non-point sources examples of which are burning of garbage in the open, manure storage, and disposal of chemicals.

> *"any factory or trade premises not kept in a clean state and free from offensive smells arising from any drain, privy, water-closet, earth closet or not ventilated so as to destroy or render harmless and inoffensive as far as practicable any gases, vapours, dust or other impurities generated or so crowded, or so badly lighted or ventilated as to be injurious or dangerous to the health of those employed therein."*

This Section although purely made to include any smallest sources of air pollution, is often interpreted to include a factory or group of factories, shelter or convenience. It calls for application of Best Available Technology (BAT) to treat (to render harmless) gases or vapours and to remove dust. It does not say the levels to be achieved, but it can be assumed that the air pollution has to be reduced to tolerable levels which are safe for humans.

In the absence of any specification, a clean factory (in sanitary terms) could escape control. One of the biggest weaknesses of this Act is that it ignores that most harmful gases may not be detected by sight or smell and hence cannot be a basis for prosecution. It is important that, these weaknesses be addressed to include physical or chemical indicators of pollution, such as destruction of physical property, ecological impact, or prevalence of diseases.

Section 118 States "

> *"any factory or trade premises causing or giving rise to smells (odours) or effluvia which are offensive or which are injurious to health will be considered a nuisance".*

This Act therefore, is likely to encompass waste treatment facilities within the factory or trade premises.

Another Section of this Act states:

> *"any chimney sending forth smoke in such quantity or in such manner as to be offensive or injurious or dangerous to health" is a nuisance*

It is left to the developer to design a chimney that conforms to the legislation, but the law does not give guidance to what would constitute a well designed chimney. In addition, mention of smoke is made. Smoke could be accompanied by invisible gases which though injurious to health are not obvious to the naked eye.

The penalties recommended by the Act in Section 121 are not deterrent enough. The burden of proof lies with the Medical Officer of Health. Rarely are medical personnel equipped with inspection capabilities for gaseous emissions. Medical officers are more often than not likely to rely on epidemiological studies and may not have the time or the inclination to venture out of the dispensary or hospital. It is also interesting that the minister for local government is called in to control the high chimneys (Section 126(4) (iii) with regard to the height of buildings and height of chimneys. Apparently, this is because the Planning Department which approves all building plans is under the Local Government Authority .

The following recommendation are suggested for this act:

(a) The law ought to include non-point sources such as sewage treatment, solid waste disposal sites, mining and quarrying, building/demolition sites, and energy generating facilities.

(b) The law should also adopt a comprehensive list of injurious chemicals.

(c) It should give guidelines on fume and smoke stacks, light, location and degree of waste minimisation.

(d) It should recognise other regulatory personnel such as from Directorate of Occupational Health and Safety Services (DOHSS), or any privately funded studies.

(e) The use of the term to which the Act prescribes the time when the penalty period is operative should be retroactive to when the complaint first came or was registered.

(f) The criteria for judging toxicity and degree of harm offensive smells should be spelt out;

(g) Section 126A (a) (ii) which allows the ministry for local government to give guidelines on chimneys also include guideline No.2.

(vi) The Workman's Compensation Act, Cap 236

In its Third Schedule, the Act specifies the nature of occupations and the diseases they can cause. The Act lists a number of chemicals which are likely to cause diseases.

This list has been found to be too restrictive in light of the fact that presently there are literally thousands of chemicals, hence, this list should be substituted with a more comprehensive one. Furthermore, the Act is insufficient in giving levels of concentrations which could be injurious.

In order to protect both the worker and the employer, a concentration description to be used as a guideline is necessary. One caution on this list is that, rarely are chemicals used in their purest form. Also chemical reactions are dynamic. It should be left to the inspector to assess the by- products, intermediate compounds or cocktails which should be assessed as having caused disease, accident or hazard. In many countries, the presence of one compound in the list which is present in unsafe quantities is a good basis for prosecution. This list should be the same list which is used in the Public Health Act and the Factories Act.

2.2.3 Weaknesses of the Existing laws

The overall difficulties in enforcing existing regulations can be summarised below:

(i) Words and phrases are too generalised and difficult to interpret as well as prove in a court of law.

(ii) Some of the statutes come into play after an act or omission has been committed, a case that is still observable in the case of Penal Code and the Traffic Act.

(iii) In the application of the law, some implementing and enforcement agencies tend to implement certain portions as opposed to others (like in the Chiefs

Authority Act- "Changaa" *visa-vis* environment) mainly because definitions would tend to compromise their authority.

(iv) There is an absence of quantified standards and guidelines.

(v) The penalties stipulated for breach of the law are very low.

(vi) There are conflicts of interest for decision makers since the major decision makers may have economic, social and political interests in the case in question and hence the reluctance of enforcement officers to pursue the case to its logical conclusion.

(vii) Most of the laws have a narrow scope of implementation, for example, with regard to effect of pollutants on health and may not look at the wider picture.

(viii) Some elements of source of pollution are left perhaps with a notion that they belong to the government and hence, are "expected" to play the lead in pollution control such as aircrafts, ships, locomotives and public utilities.

(ix) There is the sectoral application of the laws where there is no co-ordination of actions and feed back mechanisms of effects of enforcement.

(x) It has been observed that most legislation that enforce air pollution include statements like. " ...if the officer is satisfied that there is a nuisance" (air pollution). How the officer becomes satisfied is left hanging and, hence, entirely subjective.

2.2.4 The Development of a Clean Air Act

The need for a regulatory mechanism for air was recognised by the government when, in 1988, a task force was constituted under the National Environment Secretariat (NES) to prepare a draft Clean Air Act. By April, 1989, the draft Clean Air Bill (DCAB) was ready and sent to a number of relevant institutions and organisations including the Kenya Law Reform Commission (KLRC) for comment.

The draft was ready by 1991, and was approved by the Attorney General's Chambers for the Ministry of Environment and Natural Resources to write a cabinet memorandum so that clearance could be given for the draft bill to go to Parliament for debate.

Among the key provisions of the bill was the requirement for appointment of a Chief Air Control Officer and other air control officers who would enforce the resultant Clean Air Act. The draft Bill proposed control of the following parameters:

(i) smoke;

(ii) emission of grit and dust including definitions and guidelines for the measurement and control fumes from outdoor furnaces; and,

(iii) control of chimney height; and,

(iv) power of court to make a nuisance order regarding air emissions.

This is the guide that has been used to develop the present standards.

The DCAB requires sources of pollution to be comprehensively monitored including those areas hitherto uncontrolled such as railway engines, motor vehicles and government premises.

The draft bill faced immediate criticism from many quarters on the definitions of some of the parameters. For example, it placed too much emphasis on smoke fumes and dust as the only major air pollutants and the availability of the government capacity to enforce it since it would run into direct conflict with related Acts such as the Factories Act.

At the same time, there were the parallel efforts of formulating the National Environment Management Act which were going on at the time. It was felt that NEMA would encompass all the sectoral concerns of the environment. An argument was advanced that the NEMA should be considered the environmental mother bill. Later the KLRC appreciating the development of NEMA saw no conflict and indeed noted that in many other countries which have successfully legislated on environment, the air quality is addressed in a separate piece of legislation. KLRC agreed that the NEMA and the DCAB could, indeed, be debated together.

In a turn of events in 1993, a decision was made to combine NEMA, now known as the National Environment Bill and the DCAB and by October, 1994; and such a combined bill is referred to as National Environment Management Bill was ready. It is the basis for proposing the present set of standards.

2.2.5 Case Studies for Establishment of Air Quality Standards

Apparently, the need for the standards to be set has been due to demand by the public, project financiers and private initiatives. Three cases are given:

(i) Kel Chemicals, Thika

(ii) Olkaria Geothermal station, Naivasha

(iii) Athi River Portland Cement Factory

(I) Kel Chemicals, Thika

Kel Chemicals is one of the factories in Kenya manufacturing sulphuric acid from elemental sulphur by the contact process. The other sulphuric acid factory is East African Heavy Chemicals based in Webuye. From the sulphuric acid manufactured, aluminium sulphate used in water treatment, and fertiliser, are made.

Sulphuric acid is a major component in the manufacture of lead batteries where sulphuric acid is the electrolyte. In similar manufacturing cases, sulphonic acid is manufactured for the preparation of detergents. Two other factories, namely, East African Industries in Nairobi and Orbit Chemicals in Athi River manufacture sulphonic acid.

In both sulphuric and sulphonic acids, sulphur is heated under a catalyst forming sulphur dioxide which is further oxidised to sulphur trioxide. The sulphur trioxide is then dissolved in water to make 95% sulphuric acid.

In the process, fugitive sulphur oxides may escape from the stacks causing air pollution and localised acid rain. This was the basis of complaints at Thika where the community of Makongeni Estate called for either relocation of the factory or elimination of emissions.

In the absence of National Air Quality Standards (NAQS) the Government Committee recommended that WHO standards as set by WHO Task Group on Environmental Health Criteria for sulphur oxides (SO_x) in 1979 be adopted.

This was based on background emissions measured in the area at that time and empirical observations at the immediate environs such as:

(i) working environment for which safe levels stood at 5 ppm (for work up to 8 hours);

(ii) there was vegetation damage at 0.3 ppm;

(iii) smell threshold was at 0.5 ppm;

(iv) irritation of the nose and throat occurred when concentrations were 5-10 ppm; and,

(v) coughing and eye irritation at 20 ppm.

The standards formulated were:

(a) 24 hour value at 100 - 150 mg/m^3 (0.035 - 0.052 ppm); and,

(b) annual mean at 40-60 mg/m^3 (0.014 - 0.02 ppm).

(ii) Olkaria Geothermal Station

The Olkaria Geothermal Power Station is located on the southern side of Lake Naivasha.

Steam from the earth's strata is used to drive turbines which in turn generate electricity. The operation of the first geothermal station started in 1970. Stage one, producing 15 megawatts of electricity (MWe) was commissioned in 1981. Stage 2, producing a further 15MWe was commissioned in 1982 and the final 15MWe expansion was commissioned in 1985, making a total of 45MWe. The potential for further 15MWe for the next 30 years has been identified.

In all these cases, well depths of 1744 to 2497 metres below the surface have been dug. The steam contains what is referred to as geo gas which for the 32MWe station is 1.966 tonnes per hour. Most of this is carbondioxide which, apart from being a "greenhouse" gas, is a harmless component of the atmosphere. The harmful gas is hydrogen sulphide (H_2S) which is estimated to be 4.9% of the geo-gas which calculated to 20.911 grams per second. H_2S is also associated with the bad smell of sewage treatment plants, tanneries, and rotting vegetation matter. In order to minimise negative environmental impact of this gas it had to be regulated since odour is very central in mobilising people against industries.

There is considerable variation in the response of the human nose to odour. A range of odour thresholds(where 50% of the people can detect the presence of the odour have been reported for hydrogen sulphide (0.76 0 3.21 μg/m^3). It is therefore, easy to assume that the background levels of hydrogen sulphide are over 35 μg/m^3 where they are a source of complaints. It is with this background in mind that a medium of standard setting based on

quantitative assessment has been made at Olkaria. In this case, a 0.03 ppm sampled at 60 minutes intervals for residential areas have been agreed to between Kenya Power Company and the government. In other cases areas supporting commercially, culturally, or scientifically important vegetation should not be permitted to experience exposures above 0.03 ppm.

(iii) Athi River Portland Cement

Manufacture of portland cement is the basis for a sustainable construction industry in any country including Kenya. There are three major cement industries in Kenya namely, Bamburi Portland Cement Company in Mombasa North Coast, Athi River Portland Cement in Athi River, and the new Kaloleni Cement Factory in Kilifi.

Cement factories are large consumers of energy mainly heavy diesel oil and coal. Hence, they are a source of gaseous pollution associated with energy generation.

In addition, the manufacture of cement generates dust and particulate matter which are offensive to workers and the general environment. The problem of air pollution emanating from Athi River Portland Cement was a source of such major complaints of air pollution in the past. Recently, Kaloleni factory was threatened with non-commissioning because of the same problem.

Athi River attracted attention in the late seventies and the early eighties when an inter-ministerial team from the Ministries of Environment and Natural Resources, the then Water Development, Commerce and Industry and the Local Government was instructed to formulate standards and guidelines to minimise pollution of air and water. On air quality the major concern was dust emissions from the fume stack. The team proposed the following standards:

SO_2 at ground level

(a) inside the plant fence:

- Annual arithmetic mean - 100μg/m^3
- Maximum 24-hr peak - 1000μg/m^3

(b) Outside plant fence:

- Annual arithmetic mean - 100μg/m^3
- Maximum 24-hr peak - 500μg/m^3

(c) From Kiln 150/mg Feed:

- From clinker cooler 50g/m$_3$,
- Feed ground level outside plant fence 80μg/m^3,
- Stack discharge 80μ/m^3.

The standards did not specify the mode of monitoring; and that there has not been similar complaints attests to the fact that air pollution can be controlled at source using technology and emission limits. There was, HOWEVER, no requirement that the factory monitor its emissions.

CHAPTER 3

3.0 REVIEW OF SCIENTIFIC KNOWLEDGE AND TECHNOLOGY

3.1 Background

The United Nations system, particularly the United Nations Environment Programme (UNEP), the International Labour Organization (ILO), the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), in accordance with their respective mandates, have considered the potential hazards of chemical exposure. While these agencies have focused on the global implications of chemical exposure, they have shown particular concern over the potential hazards of pesticides that were imported and distributed without careful consideration of their toxic properties.

Towards the end of the 1970s, various activities in industrialised countries related to control of toxic chemicals highlighted the need for concerted and collaborative efforts to manage the environmental health problems caused by the use of chemicals. Without a multi-lateral effort to promote chemical safety, it was feared that many governments in the developing world would be unable to effectively deal with the serious risks posed by chemicals to human health and the environment.

In 1980, UNEP, ILO and WHO established the International Program on Chemical Safety (IPCS). The IPCS has worked to assess the risk due to exposure to chemicals and recommended guidelines which serve as a reference for national governments in developing their own control measures and establishing standards. One of the major activities of the IPCS is the development of the Environmental Health Criteria (EHC).

Participation in IPCS is being expanded to include other United Nations and inter-governmental bodies, including the United Nations Industrial Development Organisation (UNIDO), FAO and the Organization for Economic Cooperation and Development (OECD). The IPCS also serves as an interim secretariat for the development of an Inter-governmental Forum on Chemical Safety.

The IPCS Coordinating Group for the Harmonisation of Chemical Classification Systems was established in 1992. It provides a mechanism for promoting coordination of international activities in the area of harmonising chemical classification and labelling systems. The Coordinating group includes representatives of UNEP, ILO, WHO, United Nations Committee of Experts on Transport of Dangerous Goods (UNCETDG), FAO, OECD, existing classification system bodies, international organisations of suppliers, employers, workers and consumers, and environmental groups.

WHO intends to promote the use of internationally evaluated scientific information to enable member states to establish their own chemical safety measures and programmes.

3.1.1 Environmental Health Criteria

IPCS provides one of the major risk assessments and guidelines for exposure to chemicals to enable national governments to take regulatory action as deemed appropriate. International chemical risk assessments are published by the IPCS as Environmental Health Criteria Documents including laboratory testing methods, and risk assessment procedures.

The purpose of the Criteria concerning testing methods and risk assessment procedures is to promote the development, harmonisation and use by all countries of internationally agreed upon methods for such activities. The EHC risk assessments are based on all published data on a chemical and cover risks from all avenues of exposure, including from food ingestion, and air and water pollution.

Due to the comprehensive nature of these risk assessments, EHC are used for a variety of purposes, in addition to supporting national regulation. For example, serving as the basis for WHO Air and Drinking Water Quality Guidelines and Maximum Allowable Limits.

3.1.2 WHO Environmental Quality Guidelines

The First Conference on an International Sanitary Convention, which met in 1851, marked the beginning of international efforts to address public health issues. Following World War I, the Health Organisation of the League of Nations was created in 1919. After World War II, the International Health Conference in New York approved the constitution of the World Health Organisation. The constitution creating WHO as an inter-governmental organisation within the United Nations System entered into force on April 7, 1948.

The main functions of WHO are to direct and co-ordinate work on international health issues, and to encourage technical co-operation in health related areas with its member countries.

The Organization's specific responsibilities include:

(i) developing international standards for food, biological, and pharmaceutical products;

(ii) proposing international conventions and agreements on health matters; assisting governments, upon request, in strengthening health services;

(iii) establishing and maintaining such administrative and technical services as may be required, including epidemiological and statistical services;

(iv) providing information, counsel and assistance in the field of health;

(v) promoting cooperation among scientific and professional groups which contribute to the enhancement of health; and,

(vi) promoting and conducting research in the field of health.

3.1.3 Development Of WHO's Environmental Pollution Programmes

In 1970, the Twenty-Third Session of the World Health Assembly established WHO's long-term programme in the environmental pollution field. The Assembly's resolution establishing the programme called upon the Director-General to establish and promote international agreement on criteria, guidelines and codes of practice concerning known environmental effects on health, with particular emphasis on water and air pollution, occupational exposures, food contaminants and waste. Since then, WHO has developed international guidelines on the risks of many chemical and physical factors to health and the environment.

Air and water quality guidelines are developed under the Programme for the Promotion of Environmental Health which is carried out by WHO's Division of Environmental Health.

3.1.4 Air Quality Criteria and Guidelines

WHO's involvement in the field of air quality goes back over thirty years and precedes the establishment of its general environmental programme. WHO's first Expert Committee on Air Pollution met in 1957, and found a disturbing lack of knowledge about the health effects of air pollution which was on the increase in many countries. The Committee stressed the need for global research in the following areas:

(a) the health effects of air pollution;

(b) the ability of the atmosphere to disperse pollutants;

(c) emission controls on industrial sources of pollution; and,

(d) the use of indigenous indicators of the effects of air pollution.

The Committee also requested that WHO assist governments in drafting appropriate air pollution control legislation.

An alarming increase in the concentration of sulphur oxides in the air of many industrial cities generated a request for WHO to convene the Expert Committee on atmospheric pollutants in 1963, with the aim of developing an international approach to the air pollution problem. In 1969, an the Expert Committee on Urban Air Pollution focused primarily on the effects of vehicle exhaust on air quality. The 1969 Committee recommended further study of health effects of lead, photochemical oxidants, hydrocarbons, and particulate substances.

Both the 1963 and 1969 Committees viewed air quality criteria and guidelines as important steps in the adoption of standards; although health effects were seen as the

paramount issue in setting standards. The committees also recognised the need to consider economic factors and technical feasibility in setting standards. The expert committees recommended that air pollution control standards should be adopted by national governments based on the precautionary principle when scientific evidence was not complete.

In 1970, the World Health Assembly adopted a resolution which stated that:

"*due consideration should be given to the effect of water, soil, food and air pollution, noise and other environmental factors harmful to human health, and to the need for the establishment of environmental health criteria, guidelines for preventive measures and methods of determining priorities and allocating resources based on health problems and needs in both developing and developed countries*".

WHO responded to this resolution by convening an Expert Committee which developed the first international air quality criteria and guidelines for four major pollutant groups, that is:

(a) sulphur oxides and suspended particulates;

(b) carbon monoxide;

(c) photochemical oxidants; and,

(d) nitrogen oxides.

In recommending guidelines, the experts evaluated both acute and chronic effects of exposure to these pollutants on human health and the environment, and considered groups with particular vulnerability such as the elderly and children. In discussing the administrative use of the criteria and guidelines by governments, the report stressed that its recommendations represented a risk assessment based on the available scientific data. The Report recognised that national governments risk management decisions, that is, setting ambient air quality standards or pollution emission limitations would be based on scientific data as well as national and local geographic, economic, political, technological and other factors.

The 1972 Air Quality Criteria and Guidelines for Urban Air Pollutants served as non-binding international guidelines for air pollutants until initiation of the International Programme on Chemical Safety in 1976. Under the IPCS, Environmental Health Criteria covering the same pollutants as those covered under the 1972 Air Quality Criteria have been issued. The Environmental Health Criteria specifically endorse or modify the 1972 Air Quality Criteria and Guidelines.

Air pollutants covered under the Environmental Health Criteria remained unchanged until 1987 when WHO's Regional Office for Europe issued Air Quality Guidelines for Europe.

3.1.5 Air Quality Guidelines For Europe (1987)

In 1983, the Government of the Netherlands approached the WHO Regional Office for Europe, to suggest that the organisation develop air quality guidelines for the region. WHO agreed to develop non-binding guideline values based on scientific risk assessments in making risk management decisions concerning ambient air quality and pollution emission limitations from specific sources.

The Air Quality Guidelines for Europe are the product of work by approximately 150 experts, participating in WHO organised meetings, working groups and consultations. Although primarily from European countries, there were some work-group members from the United States and international organizations, in particular, the United Nations Environment Programme.

At an initial planning meeting to discuss development of the guidelines, criteria for selection of the pollutants to be covered were established. The experts chose air pollutants of special environmental and health significance to countries of the European region based on the following criteria:

(a) severity and frequency of observed or suspected adverse effects of the pollutant on human health, particularly irreversible effects;

(b) distribution and abundance of the pollutant in the environment;

(c) the pollutants tendency to be chemically altered in the environment, particularly if such a transformation might result in the production of chemicals more toxic than the original pollutant;

(d) the pollutant's biodegradability and bio-accumulation in the environment, humans, or at any level in the food chain; and,

(e) the size and nature of the population exposed to the pollutant. Based on these criteria, the Working Group selected 28 pollutants for evaluation.

3.1.6 Framework for the Development of Environmental Management Standards

WHO Technical Committee number 207 has established a policy framework for developing international environment management standards. The Committee will strive to develop standards that advance the state of environmental management and assist in harmonising national and regional standards. These standards should be adaptable for internal or external verification, certification, or registration, and should be cost-effective, non-prescriptive, and flexible. The standards also should be based on sound, objective criteria supported by scientific principles.

The Committee is not a policy setting body and will not develop test methods for monitoring pollutants, emission limitation values for pollutants, environmental performance level or product standards. In addition, its environmental management standards will not prescribe the manner or content of an organisation's disclosures concerning its environmental management system to external or internal parties. In order to develop international environmental management standards, Technical Committee 207 has created seven Sub-Committees dealing with standards.

3.1.7 International Standards Organisation

The International Standards Organisation (ISO) is a world-wide federation of national standards bodies (ISO member bodies). Kenya is a member of ISO through the Kenya Bureau of Standards. The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International Organisations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft international standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard, requires approval by at least 75% of the member bodies casting a vote.

International Standard methods for both sampling and analysis are produced by ISO and each standard is dated to show when it was first promulgated. There is a series of air quality, water quality, and soil quality standards. Each is published separately so that it is up-dated without the entire set of standards being published every time there is a modification to an existing standard or a new method or procedure is adopted.

It has been observed elsewhere that national standards on each of these media are tending to converge on the ISO standard. ISO standards are adopted as national standards or produced as exact matches or technical equivalents of the relevant ISO standard.

Over the last decade, Kenyan efforts to reduce the environmental impacts resulting from industrial operations and services have been changing focus.

Governmental promotion of traditional command and control approaches such as end of pipe treatment has been reduced in favour of waste minimisation and other cleaner production approaches.

Environmental regulations of many countries are intended to ensure that pollution effluents do not exceed maximum threshold value, so as to limit the level of negative impacts of operations and waste effluent on the environment and human health.

The ISO 14000 standard is intended to supplement the regulatory based environmental management practices required of manufacturing and service industries by promoting proactive identification and management of enterprise activities impacting on the environment.

3.2 Air

Definitions

"Air Pollution" is defined as the introduction by man, directly or indirectly, of substances into the air which results in harmful effects of such nature as to endanger human health, harm living resources and ecosystems, cause material damage, interfere with amenities and other legitimate uses of the environment.

Air pollutants can be solid (dust and particulates), liquids or gases. Aerosols are produced when gases and liquids are mixed . The changes of the pollutants from one state to another is a function of the temperature, pressure, chemical and physical circumstances that give rise to them. In addition, air pollutants abundance in air is related to the abundance at source.

Quantitatively, the three important life cycles, namely, the sulphur cycle, the nitrogen cycle and the carbon cycle, play a big role in contributing to air pollutants and also as sinks of excess of these gases.

Anthropogenic sources is a term to describe man-made sources such as industries, chemical usage, and transport. They are usually the regulated sources.

3.2.1 Importance of Air Pollution Control

Air in its natural state is life supporting. It is harmful only when its composition has been changed by the introduction of harmful substances to it. Composition of natural unpolluted air is given in **Table 3.1.**

In Kenya, the main cause of high incidence of diseases of the upper respiratory tract is suspected to be due to the presence of pollutants in the atmosphere, in residential, and working places. It has been observed that there is also a correlation between levels of air pollution, social, economic, technological and the capacity of the country to enforce its laws.

Morbidity patterns in Kenya closely relate to causes of mortality. Over the years, malaria and acute respiratory infections (ARI) accounted for almost half of the reported visits to the outpatient facilities. In-patient morbidity depicts the same trends as outpatient where malaria leads with 26% of the total reported in patients closely followed by ARI which account for 22% of the cases. From this stand-point alone, it is apparent that the country's medical expenditure goes to air pollution related diseases as is shown in **Table 3.2.** Reducing this pollution can be achieved by enforcing air quality standards.

Table 3.1 Leading Reported Causes of Illness and Deaths in Kenya, 1995

Causes of Death or Illness	Percent Reported Cases
Malaria	26.0
Respiratory Diseases	22.0
Eyes, ears, Anaemia, trauma etc	21.0
Skin	7.0
Intestinal parasites	5.0
Diarrhoeal diseases	4.0
Protein Energy malnutrition	1.4
Others	13.6

Source: *Health Information System Records, 1995*

3.2.2 Objectives of Air Quality Standards

Air quality management aims at ensuring that an environmentally safe level of air pollutants is maintained so as to protect human health and the environment. For health the effects of some air pollutants are more threatening than others. They can be grouped as below:

Group I:

Life threatening injury, where injured persons may have intense irritant-induced cough, respiratory insufficiency, and systemic effects.

Group II:

Severe injury where injured persons will have strong irritant-caused cough, respiratory difficulties, but no systemic effects.

Group III:

Mild injury, where persons may have moderate or mild irritant caused cough, eye-symptoms/signs and possibly headache.

The air pollutants to be discussed and for which standards need to be developed are those that fall under all of the above groups.

3.2.3 Composition of Natural Unpolluted Air

Composition of air is as given in **Table 3.2.** Other constituents found in normal air include cosmetics such as perfumes; solid particles such as dusts; chemical gases and their intermediaries; aerosols and dust, are not included in **Table 3.2**. Their addition to air makes it unclean or polluted.

Table 3.2: Chemical Composition of Air

Constituent	Symbol	Molecular weight	Molecular fraction of air	Mass Fraction of air
Nitrogen	N	28	0.7809	0.755
Oxygen	O_2	32	0.2095	0.232
Argon	Ar	40	0.0093	0.013
Carbon Dioxide	C_{02}	44	320ppm	486ppm
Neon	N_e	20	18ppm	12ppm
Helium	H_e	4	5.2ppm	0.7ppm
Methane	CH_4	16	2.9ppm	1.6ppm
Krypton	Kr	84	1.1ppm	3.2ppm
Nitrous Oxide	N_2O	44	0.5ppm	0.8ppm
Hydrogen	H_2	2	0.5ppm	0.03ppm
Ozone	O_3	48	0.01	0.02pp

Source: *Garrels, Mackenzie and Hunt, Chemical Cycles, 1978*

3.2.4 Priorities for Air Pollution Control in Kenya

This is essential that the issues of air pollution are identified with a view to solving environmental problems; and the proposed logical steps to follow are as outlined below.

Priority 1: Those with local impacts to structures, health, soil, and water. These are generally environmental impacts such as acid-rain.

Priority 2: Those with global impacts such as global warming and ozone layer depletion.

(i) Acid Rain

Both "wet deposition" acid rain, snow, fog, and cloud vapours and "dry" deposition-acidic particulate and aerosols, are formed when large volumes of sulphur dioxide(SO_2) and nitrogen oxides(NO_x) are released from the combustion of fossil fuels.

Stationary sources such as coal burning power plants, ore smelters and industrial boilers, are responsible for nearly all human caused SO_x emissions and for about 35% of human caused NO_x emissions.

Smoke stacks emit gases into the atmosphere where most are converted to sulphate and nitrate particulates and distributed down-wind. The phenomenon of acid deposition is largely associated with highly industrialised regions of Europe and North America. In Kenya, it is localised to specific industrial environs.

Localisation of acid-rain in Kenya is mainly related to sulphuric and sulphonic acid manufacturing plants. Indicators of acid-rain normally include ecosystem damage, damage of physical structures like corrosion of marble and metal building materials.

Increasing attention is now being paid to the health effects of acid aerosols derived from chemical transformation of SO_x and NO_x in the atmosphere. Mounting evidence suggests that aerosols may damage human health by contributing to respiratory problems such as bronchitis and asthma.

In Kenya, an indicator of the level of acid rain producing SO_x has been investigated (by Kollikho, 1995). The measurements of SO_x were carried out under Global Environmental Monitoring Systems (GEMS)/AIR programme in 1977/78. The 98th percentile was found to be 25μ/m^3 at the city centre, 41μg/m^3 at a residential site, 15μg/m^3 at a sub-urban site and 142μg/m^3 at the industrial area in Nairobi.

Deposition of SO_2 emitted by industries (Nganga, 1976) located in major industrial areas in Kenya were estimated using a Gaussian approach. The central parts of Kenya were shown to have the highest deposition rates of 7-17 gm/cm^2/s compared to 2-4 x 10^{-7} gm/cm^2/s in western, eastern and northern parts of Kenya which were attributed to the large number of industries in Nairobi and Thika which are located in the central region.

(ii) Global Air Pollution Issues

The global concern comes about when the impact of pollution of air is extended locally, regionally, and globally in that order.

As a rule of thumb, most local impacts have health and aesthetic negative impact while the regional and global changes may in addition have impacts on climate, affect the structure, ecosystems and other life support systems. The air pollution issues of global significance are therefore, ozone layer, depletion global warming and climate change.

Ozone Layer Depletion

Particles, when released into the atmosphere are removed within hours to weeks by one of three general processes: by absorption of sunlight (photolysis), by dissolution in water droplets (rain-out) or by reaction with hydroxyl radical, HO, or Ozone O_3 (oxidation).

a group of chlorinated halogenated hydrocarbons, namely, chlorofluorocarbons (CFCs) and bromochlorocarbons (halons) are stable for the above processes. CFCs, halons, carbon tetrachloride, and their intermediaries are transparent, insoluble, and unreactive to atmospheric oxidising agents; so none of the above processes affect them and they can last for a long time in the atmosphere. Their molecules are carried into the stratosphere by great storms in the equatorial region. There, 25 to 35 kilometres, they are destroyed by intense, very energetic solar ultraviolet radiation. This UV-C radiation is not present in the lower earth surface because it is strongly absorbed by ozone in the stratosphere and the CFC molecules have to rise above most of this before they encounter it. Ozone, the triatomic form of oxygen (O_3), mostly exists where it is created, high overhead in the stratosphere, when ordinary diatomic form of oxygen O_2 is broken into two oxygen molecules by absorbing the C-radiation which reacts with the strong halogenated molecules commonly known as the ozone depleting substances (ODSs). Most of the ODSs are consumed in refrigeration, foam blowing, degreasing, as solvents, in agriculture, and dry-cleaning.

Currently, ozone is being monitored in Kenya by the University of Nairobi Chiromo campus. IN addition the World Meteorological organisation, plans to set up a global ozone monitoring station on Mount Kenya as part of the Global Environment Facility Global Ozone Observatory stations.

In 1993, with a population of 25 million people Kenya consumed 181 tonnes of ODSs with a consumption *per capita* of 0.0072 kg. By 1997, the consumption rate had increased to an estimated 600 metric tonnes because of the inclusion of methyl bromide as a controlled substance

Chlorofluorocarbons (CFCs)

There are two CFCs currently in major use in Kenya namely CFC-11 and CFC-12. The CFC-11 is mainly used in polyurethane foam blowing for insulating panels for domestic refrigeration. Consumption of CFC and hence, its importation was 100 metric tonnes per year. It is expected that this level has gone up because the major user is still using the same technology. There has been a move in other sectors of foam blowing to move away from CFC-11 and use methylene chloride instead.

Other users of foam blowing are importing foam blowing chemicals already pre-mixed and data on current consumption is not very accurate. The aerosol sector was the major user of CFC-12 (150 tonnes in 1989). By February, 1993, practically all the users of CFC-12 in aerosols had converted to using butane as propellant and hence, this precipitated a drop in the use of CFC-12. The main use of CFC-12 now is in refrigeration and air conditioning of which 100 metric tonne are estimated to be in use per year.

Methyl bromide is one of the most important ODSs currently used in the agricultural sector. The current consumption is mainly in cut-flowers, fumigation, pre-shipment and quarantine purposes. Current imports stand at 400 metric tonnes. Due to the fact that Kenya ranks fourth in production of cut-flower and that this is one sector showing tremendous growth, it is expected that consumption is likely to grow. Since this is a specialised use, where no viable alternatives exist, users have not been able to switch to alternatives and so long as supply is available consumption is likely to grow.

Policy measures to reduce the use of ozone depleting substances include the ratification of the Vienna Convention and Montreal Protocol.

The phasing out of ODS in Kenya according to the country programme, envisages the following:

- conservation of existing stocks;
- introduction of alternatives to new installations and equipment;
- legislating against their imports, and
- recycling.

Climate Change

Climate and climatic variability have a direct impact on socio-economic activities. Disastrous effects of droughts, floods and local changes in climate are continually being felt in many parts of the country. Yet, there is no comprehensive mechanism or strategy to contain or mitigate the effects of climate. It is desirable that the seasonal patterns that have guided Kenya's development do not change. Unfortunately scientific evidence indicates that this is not so . In the past policy measures have been taken in order to monitor the climate and atmosphere of the country in order to better guide land-use and economic development decisions, and better manage air pollution and greenhouse gas emissions.

There are two types of sources of air pollutants that can cause global warming and consequently climate change, namely, point sources such as industries and vehicles, and non-point sources such as land use and forests.

CO_2 is the most common greenhouse gas produced by anthropogenic activities.

By far the largest source of CO_2 emissions is from oxidation of carbon when fossil fuels are burnt which accounts for 70-90 percent of the total anthropogenic emissions. When fuels are burned, most carbon is emitted as CO_2 immediately during combustion process. Some carbon is released as CO, CH_4, or non methane hydrocarbons which oxidize to CO_2 in the atmosphere within a period ranging from a few days to 10-11 years. It is possible to get an accurate estimate of national.

Since fuel combustion is widely dispersed throughout most activities in the national economy, it is possible to obtain an accurate estimate of CO_2 emissions by accounting for the carbon in fuel supplied to the economy.

Table 3.3: Green-House Gas Emissions in Kenya ('000 metric tonnes)

	CO_2	CH_4	ODSs
Kenya	5,192	640	0.5
Africa	647,352	19,000	16.0
World	21,863,088	270,000	580.0

Source: *World Resources Institute, 1989*

The *per capita* carbon dioxide emissions is for the World 4.21 metric tonnes, Africa 1.03 metric, tonnes, and Kenya 0.22 metric tonnes.

The conclusions from the ozone layer and climate change considerations is that, both are not high priorities in Kenya and setting emission standards for them is pre-mature. Besides, the present exercise is to develop a methodology for setting standards.

3.2.5 Indicators of Air Pollution in Kenya

In Kenya, pollution from anthropogenic sources fall in the following order in terms of distribution of contributors:

- land use;
- transport;
- animals/agriculture;
- mining and transport of mined products;
- solid waste disposal;
- building and construction;
- industries; and,
- electrical appliances.

3.2.6 Scientific Knowledge on Priority Pollutants

The pollutants discussed here below are chosen by virtue of their abundance in air and their potential impact to the health of people, animals and the general ecosystem.

(a) Oxides of sulphur

(b) Oxides of Nitrogen

(c) Oxides of Carbon

(d) Dust Particles

(e) Vaporous organic Compounds

(f) Inorganic air pollutants

Few of them have routinely been physically monitored in Kenya. At best there have been isolated cases of measurements for academic interest. In order to assess their importance to Kenya's need for a regulatory mechanism, a brief history of their monitoring in Kenya is outlined below.

(i) Oxides of Sulphur and Suspended Particulate Matter

Sulphur dioxide and suspended particulate matter are usually emitted together during combustion of fuels and can be counted among the most prevalent air pollutants from all categories of emissions. The combined health effects of sulphur dioxides and suspended particulate matter are usually studied because there is a general understanding that a synergistic (potentiating) effect occurs when both forms of pollution are present in air. In fact epidemiological studies have not been able to identify the individual effects of either of these forms of air pollution.

Characteristics

Minute quantities of sulphur dioxide, hydrogen sulphide and particulate sulphates are present naturally in air. Gaseous sulphur compounds are emitted into the atmosphere through volcanic action, bacterial action in the soil, and from surface waters containing less than normal levels of oxygen. Suspended particulate matter can result from dust storms, forest fires, sugar-cane harvesting, and grassland fires.

In setting up air quality standards, it is often understood that the focus are the man made sources. Although anthropogenic quantities are almost of the same order as the natural fluxes, the anthropogenic emissions are usually concentrated in areas of dense human population and/or industrial activities.

Suspended particulate matter

Suspended particulate matter are emitted during the burning of coal but burning of oil and petroleum products do also contribute a certain level. In Kenya, the main sources of particulate are industrial activities, agriculture

dust-storms and mining and quarrying. Road transport is also a major contributor. Road traffic adds black smoke to the total particulate emission as does the incineration of domestic and commercial waste.

Suspended particulate matter generally includes a large variety of substances, depending on the source. Individual particles are composed of different chemicals and may also vary in size and shape. The effects of airborne particulate matter on the physical environment and vegetation and the ability to control man-made particulate emissions depend to a considerable extent on the particle size. Particles from as low as 0.1μm up to 5-10μm are generally referred to as suspended particulate matter (SPM); but there is no clear dividing line between, them and the larger particles usually evident as dust-fall that fall rapidly close to source as in quarries and excavations.

In many countries, the term "smoke" has been used in describing SPM based on its soiling properties and "Total Particulate Matter" for those based on weight. These two terms are not interchangeable.

Once, either sulphur dioxide or SPM have been emitted from whichever source, the extent to which either remain in suspension in the vicinity of the source is largely determined by wind speed and turbulence. Other important factors affecting the dispersion of pollutants include the height of the chimney for the source, the exit velocity of the waste gas and the local topography. It is for this reason that the dispersion of air pollutants in the Kenya air space is highly localised and area specific.

Removal From Air

Sulphur dioxide eventually returns to the land or other surfaces either unchanged or with rain and dew after conversion to sulphur compounds. Of special importance here is the conversion to the much more toxic sulphuric acid by photochemical reactions which play havoc with galvanised sheeting commonly used as roofing material in Kenya. It is this secondary effect that has been hitherto used as an indicator of air pollution in areas deemed to have high emissions as evidenced at Thika near Kel Chemicals and at a number of tanneries.

Suspended particulate matter is also removed gradually from air by a variety of processes, including impaction or diffusion on to surfaces, wash-out by rain giving the fresh air feeling after the rainy season and gravitational settling. The rate of removal depends on the physical characteristics of the particles.

Environmental Concentrations

Outdoor concentrations of sulphur dioxide and particulate matter are the more measured quantities in urban areas more extensively than in other pollutants.

As mentioned earlier, the highest levels are in the urban and industrialised areas. Most cities have a network of air pollution monitoring sites enabling contour lines connecting points of equal pollution (isopleths) to be drawn on a map. Although concentrations vary considerably in different areas, the annual mean sulphur dioxide concentrations are generally in the range of 100-200μg/m^3 (0.035-0.070 ppm). The highest daily means may be three or four times higher. Annual average for smoke in urban areas range from 30-2,000μg/m^3. With the highest daily average in the order of 150-1000μg/m^3. It is important to stress that large variations in the concentration of these pollutants are possible even with shorter averaging times and the activity occasioning the emissions during the period of measurement. This could be from hour to hour or minute to minute. In order to be more practical, data on sulphur dioxide and SPM are usually reported as average 24-hour (daily) concentrations.

Indoor Sources

The levels of indoor air pollution are usually important for the old and young; however, indoor concentrations of sulphur oxides and smoke are generally lower than outdoor levels. This is not the case in Kenya. Elsewhere increasing attention is now being given to studying indoor pollution levels because of problems associated with the reduction in ventilation to save energy, and air pollution produced indoors from cooking and smoking.

Exposure of workers to air pollutants in industry is liable to be much greater than that experienced by the community at large. Sulphur dioxide exposure, for example, may be quite high in plants manufacturing using this gas, such as paper mills, sulphuric acid plants, steel works, non-ferrous foundries, and oil refineries. The risk of exposure is usually confined to work areas and is intermittent.

(ii) Oxides of Nitrogen

Oxides of nitrogen emanate from the manufacturing processes of nitric acid, explosives, and fertilizers. They are also produced by fermentation of crops stored in silos. Cooking, heating, and cigarette smoking are indoor sources of these pollutants.

Exposure levels

Since oxides of nitrogen have been shown to give rise to both short-term and long-term effects, the ambient concentrations are normally expressed as short-term peak concentrations and long-term averages. Though it is difficult to generalise, annual mean nitrogen dioxide concentrations in urban areas throughout the world are typically in the range of 20-90 μg/m^3. The highest daily means are in the range of 130-400 μg/m^3 and the highest hourly mean values are 240-850 μg/m^3. For nitric oxide, the annual average concentration ranges from 49 to 95 μg/m^3.

Exposure from indoor sources such as home appliances and also from smoking should not be under-estimated. Tobacco smoke has been reported to contain nitrogen dioxide levels of 150-226 μ/m^3 and nitric oxide levels of 98 to 135 μ/m^3.

Effects of exposure

Evidence on the health effects of oxides of nitrogen have been derived from experiments on laboratory animals and from studies of human populations. The latter consist of controlled exposure studies (in which volunteers are exposed over short periods of time to small amounts of pollutants), studies of accidental and industrial exposures, and community exposure studies. Only the effects of nitrogen dioxide concentrations (as measured in the air) have any significant biological effects.

Over the last 15 years, a large number of experimental animal studies have been conducted into the effects which exposure to nitrogen dioxide is likely to produce. In these, a wide range of animal species, most commonly mice and rats, have been exposed to concentrations of nitrogen dioxide ranging from 100 μ/m^3 to over 70,000μ/m^3 for varying periods of time. Results have shown that the inhalation of nitrogen dioxide can lead to a series of effects depending on the concentration length and mode of exposure, the species of animal tested, and the presence of infectious agents.

These effects include structural changes of lungs, increased speed of breathing, alteration of immunological reaction and decreased performance.

Among the effects observed at the lowest exposure rates were the following: damage to lungs of rabbits was observed after exposure to nitrogen dioxide concentrations of 470μg/m^3 4 h/day, 5 days/week for 24 to 36 days. Also, inhalation of nitrogen dioxide concentration of 940 μg/m^3 for 4 hours has led to significant morphological changes in the mast cells of the lungs in rats.

Effects of NO_2 on humans have been studied in experiments on both healthy volunteers and volunteers with pre-existing respiratory illness. These studies show that the human respiratory system is affected by exposure to NO_2. When healthy volunteers were exposed to 1300-3800 μg/m^3 of NO_2, for 10 minutes, changes were observed in the air passages which caused difficulty in breathing. As NO_2, levels were increased further, the effects became more severe.

Asthmatics were exposed to 190 μg/m^3 NO_2, for 1 hour and were then given a drug which causes air passages to become constricted. The extent of constriction was greater when the volunteers were first exposed to NO_2, than when the drug was administered without NO_2, exposure. Constriction of air passages would reduce the efficiency of intake of air by the respiratory system. In another study, healthy volunteers were exposed to what amounted to simulated urban air, which in addition to NO_2, also included small amounts of ozone and sulphur dioxide. Again, signs of reduced respiratory function were seen, but in a mixed atmosphere like this it is very difficult to link the effects with a particular substance.

Several epidemiological studies have been reported in which an attempt has been made to relate pulmonary function to nitrogen dioxide exposure. The results of these studies, however, have either failed to demonstrate a significant difference in lung function between the groups exposed to different levels of nitrogen dioxide, or have been confounded by the fact that relatively high concentrations of other pollutants were present.

A nitrogen dioxide concentration of 940 μg/m^3 (0.5 ppm) was selected as an estimate of the lowest level at which adverse health effects due to short-term exposure to nitrogen dioxide could be expected to occur. Although the task group that prepared the criteria document was aware that one study in man showed effects at a lower concentration, it was of the opinion that this required confirmation.

By adopting a minimum safety factor of 3-5, a maximum one hour exposure of 190-3204g/m3 (0.10 - 0.17) ppm should be consistent with the protection of public health and this exposure should not be exceeded more than once per month. In view of the evidence of the interaction of nitrogen dioxide with other coexisting biologically active air pollutants, and because some populations are highly sensitive to this substance, there may be a need to increase the safety factor and, thus, reduce the maximum permissible exposure levels.

Owing to lack of information on the effects of long-term exposure to nitrogen dioxide in man, only a short-term exposure limit has been suggested.

(iii) Photochemical Oxidants

Photochemical oxides are from many pollution sources. Therefore, natural air movements and the frequency of stagnant periods are of great significance. Also, chemical reactions are normally favoured by high temperatures. The photochemical processes just described are not limited to reactions with man-made pollution. They also occur, to some extent, under natural circumstances with hydrocarbons produced by vegetation. For example, the characteristic haze present over large pine forests is thought to result from such processes.

The upper layers of the earth's atmosphere contain considerable amounts of ozone which is sometimes carried down to the earth's surface by down-draughts in the normal atmospheric circulation. Ozone is also produced naturally by electrical storms.

Environmental concentrations

In the context of this report, photochemical oxidants include ozone, nitrogen dioxide and peroxyacetylnitrates. As more than 90% of the total oxidants is in the form of ozone, however, the results of ambient air monitoring are normally expressed as concentrations of ozone.

Due to the acute effects of oxidant-type air pollution and the rapidly changing pollution pattern, both, during the day and from place to place, peak-hour levels of ozone are generally determined in monitoring. Determining the number of hours per day, weeks, season, or year during which a specified concentration is exceeded is also a useful means of reporting the magnitude of the ozone problem.

While natural background levels of ozone vary considerably with latitude and season of the year, they generally range from 10 to 100 $\mu g/m^3$ (0.005 to 0.05 ppm); however, ozone levels may exceed background levels in some rural areas because of the long-distance transportation of air pollutants from urban areas.

(iv) Carbon Monoxide

Carbon and oxygen combine to form either carbon monoxide (CO) (incomplete combustion) or carbon dioxide (CO_2) (complete combustion). Whereas carbon dioxide is inert, carbon monoxide is a potent poison owing to its ability to form strong bonds with the blood pigment, haemoglobin. Carbon monoxide is produced naturally, but the major man-made source is the motor vehicle - especially petrol-driven cars. Cigarette smokers subject themselves to further exposure by inhaling CO in the smoke.

Carbon monoxide is an odourless, tasteless, colourless gas under normal ambient conditions, and is emitted into the environment from both natural and man-made sources. These include the oceans, the oxidation of atmospheric methane, volcanoes, forest fires and electrical storms. There is some doubt about the amounts of carbon monoxide produced globally by natural sources; however, man-made sources are currently estimated to yield approximately 600 million tonnes per year. Over half of this comes from petrol-driven motor vehicles and a third from stationary sources such as coal and oil combustion, industry and the burning of refuse. Indoor sources of CO include kitchen stoves and certain types of heater. In some occasions, high levels of CO have been measured inside cars and buses.

Exposure

Human exposure to carbon monoxide can be estimated either by the measurement of the CO concentration in the air or by the measurement of carboxyhaemoglobin (HbCO) in the blood. In ambient air, it can be monitored continuously and automatically by non-dispersive infrared spectrometer or semi-continuously by gas chromatographic methods. Both these techniques can detect CO levels as low as 0.02-1.0 mg/m^3 of air. Portable detector tubes are also used for less accurate estimations and their limit of detection is about mg/m^3. The carboxyhaemoglobin levels in blood are measured by analysing venous blood by automated spectrophotometers. Concentrations in blood that are expressed in percentages indicate the proportion of haemoglobin that is saturated with carbon monoxide.

Environmental Concentrations

Urban CO concentrations vary with the density of petrol-driven vehicles and most cities have CO peak levels that coincide with morning and evening rush hours. Variations in these levels are also influenced by the topography of the streets and buildings as well as the weather. The variability in ambient concentrations is only slowly reflected in the HbCO levels in humans as it takes from 4 hours to 12 hours for equilibrium to occur between air levels and blood levels. Thus, environmental concentrations tend to be expressed in terms of 8-hour average concentrations. The presentation of such data as moving 8-hr averages over the day rather than as 3 consecutive non-overlapping periods has the advantage that, it presents a picture closer to the human

body response. For example, in 1973 8-h averages in the USA ranged from less than 10gm/m^3 to 58 mg/m^3, with most of the values being less than 30 mg/m^3, while in Japan, averages rarely exceeded 23 mg/m^3. In Los Angeles, the daily 8-h average ranged from 7 to 49 mg/m^3 in 1973.

Carbon monoxide is widely generated indoors by heating and cooking appliances, particularly if they are operated in poorly ventilated rooms. However, most exposures from indoor sources are lower than those produced by smoking cigarettes. Some individuals may also be exposed to CO in the course of their work. Persons likely to be exposed include traffic policemen or wardens, garage workers, employees at metallurgical, petroleum, gas or chemical plants, and fire fighters.

Such occupational exposure can be considerable. For example, concentrations of CO in garages have been shown to reach levels as high as 600 mg/m^3 and workers in such places may exhibit HbCO levels up to five times higher than normal. Highway inspectors have been shown to exhibit HbCO concentrations from 4% to 7.6% (smokers) and 1.4% to 3.8% (nonsmokers) during a day's work. By contrast, HbCO levels in the general population rarely exceed 1%, although a study of 18 urban areas in North America showed that 45% of non-smokers exposed to ambient CO had HbCO levels exceeding 1.5%. When considering such "background" levels it is important to remember that humans themselves produce CO during normal metabolic processes. Such endogenous production probably accounts for about 0.1-1% of the total HbCO in blood.

Effects of exposure

The most important biological characteristic of CO is its affinity for haemoglobin, the oxygen-carrying pigment of the red blood cells. This results in the formation of carboxyhaemoglobin (HbCO) which is over two hundred times more stable than oxyhaemoglobin (HbO_2). The relatively slow breakdown of HbCO results in the prolonged exclusion of such red cell pigment molecules from oxygen-carrying duties, and this can have serious, even fatal, consequences for the poisoned organism. In addition, muscle metabolism and intra-cellular enzyme function may be impaired by similar stable CO bonding. This aspect of CO toxicity may be minor in healthy humans, but can be of crucial importance in someone suffering from pre-existing heart muscle malformation or poor peripheral blood circulation.

The effects of CO in man appears to vary depending on the pre-existing state of health. Some fat people seem capable of tolerating HbCO levels as high as 40% for short periods but persons with heart or lung disease may succumb to HbCO levels of 5-10%. The effects of high concentration of CO on the central nervous system and cardiovascular system are well known; however, the response of healthy people to lower levels of CO, especially for long periods, is less clear. For example, the performance of vigilance tasks such as those involving the ability of an individual to detect small changes in his environment taking place at unpredictable times and demanding continuous attention may - be impaired by HbCO levels below 10% and even as low as 5%. (This is roughly equivalent to CO levels in air of 80 and 35 mg/m^3 respectively). Such effects are less noticeable in smokers, presumably because they are habitually exposed to similar concentration in cigarette smoke.

Studies on healthy volunteers exercising as hard as possible (maximal oxygen uptake studies) show that collapse may occur at HbCO levels of 50%. Higher work, at 70% maximal levels for 5-60 minutes, is not impaired by HbCO levels of 33%, but the heart rate is disproportionately elevated. Longer-term studies of 4 hours' work at HbCO level of 5-6% show similar heart rate effects but little else. Results seem to indicate that, for non-smokers at least, a linear relationship does exist between HbCO and decreased maximum oxygen capacity.

Although high levels of CO can cause blood pressure changes, accelerated heart rate, abnormal heart rhythm, heart failure, and peripheral blood vessel damage, data on the cardiovascular effects of low-level CO exposure is scarce. The known association of smoking with increased risk of coronary heart disease suggests that CO may be playing a part in the genesis of such disease. (Heavy smokers commonly have HbCO levels as high as 15%.) Nevertheless, it has not yet been proven that carbon monoxide, *per se*, causes heart or lung disease, but its ability to impair oxygen transport in the human body has serious implications for persons with pre-existing heart or lung pathology. Epidemiological studies of cardiac morbidity or mortality by area and ambient CO concentrations are difficult to interpret. Chest pain when making a physical effort, however, certainly seems to occur earlier in patients exposed to CO concentration of 60 mg/m^3, resulting in HbCO levels of approximately 5%.

Although pregnant women and their foetuses have elevated endogenous CO production, additional exogenous exposure may lower the tissue oxygenation and placental function, leading to babies with a lower birth weight. This may explain why women who smoke heavily have babies of lower than normal birth weight. Two other aspects of the health effects of CO are worth noting. Firstly, in animals

it seems possible that adaptation to CO can occur, as shown by their ability to tolerate, with apparent ease, acute exposure to higher concentration; this, however, needs confirmation. Secondly, in relation to occupational exposures to CO, disturbing new development is the realisation that at least one halogenated hydrocarbon, methylene chloride (dichloromethane), can cause elevated HbCO levels due to its metabolism in the body following absorption. As this compound belongs to a group of solvents introduced into industry to replace highly toxic materials like carbon tetrachloride, clearly a reappraisal of their occupational safety is required.

3.2.7 History of Emission Monitoring

(i) Total Suspended Particulate

The early incidence of survey of air pollution level in Nairobi and other parts of the country were conducted in 1982.The industrial areas of the city had the highest levels of concentration of total suspended particulate pollutants. The level fell with increasing distances from the industrial area. This indicate that industrial areas in the main source of particulate pollutants for Nairobi (**table 3.4**).

Average for all stations 1982 is 122μg/m^3 125 μg/m^3. Average for residential areas is approx 90 μg/m^3. The general trend is an increase in pollution.

Table 3.4: Results of Total Suspended Particulate Analysis

Location	Mean Concentration (μg/m^3)	
	1982	1992
Industrial area	252	397
Buruburu Phase (iv)	80.6	100
South C	103	69
Woodley	83	100
Shauri Moyo	92	150

Source: *NES*

Particulate is a major cause of respiratory diseases acting synergistically with other pollutants. The Directorate of Occupational Health and Hygiene (DOHSS) has tried to link particulate in work places with various disorders. One study carried in 1983-84 involving 5 textile industries and two cotton ginneries was intended to relate sisal dust in textile industries and cotton dust ginneries to upper respiratory tract infections (URTI). One textile factory had 19.7% of the workers examined with clinical and radiological evidence of byssinosis. 24.2% of the workers in a ginnery had similar findings. In another study in a sisal industry the prevalence rate was 16.3% in the crushing section and 5.7% in the decorting section. These are areas with the highest dust measurements.

Ambient concentration of dust and particulate matter has been estimated by Gatebe *et al.* (1995).

According to their report, the total suspected particulate levels during the sampling period for ambient air varied between 10-50 mg/m^3 for both filter sizes and they assert that while TSP values increased with increased wind speed, the level at the station indicated a constant value over the two years. The WHO guidelines for suspended particulate matter gives an annual mean of 40-60mg/m^3 by the black smoker soiling method and total suspended particulate matter of 60-90mg/m^3.

(ii) Acidic Precipitation

In 1982 measurements of acidity of rain water in selected stations in Kenya revealed that there has been acid rain in Kenya. By acidic it is meant the rain water whose pH is less than 5.6. The acidity was higher in the vicinity of Nairobi than in other remote areas. This was to be expected since Nairobi had a larger number of emission sources of acidic gas compared to the rest as shown in **Table 3. 2.**

Table 3.5: Acidic Precipitation in Kenya

Location	Average pH Value
Nairobi	5.52
Kericho	6.1
Meru	6.3
Garissa	7.1
Webuye	5.0
Thika	6.6

Source: *State of Kenya Environment, UNEP, 1986*

(iii) Carbon Monoxide (CO)

Average ambient concentration levels of carbon monoxide in Nairobi associated with emissions from motor vehicles showed that concentrations of CO can reach as high as 15 ppm using the criteria for vehicles without emission controls. In Kenya, as will be seen later, invisible gases are not monitored. On the average, the concentration levels were found to be around 5 ppm.

In a study done in 1993/94, the morning and evening peak completed maxima for CO were as shown in **Table 3.5.**

Table 3.6: Concentration of Carbon Monoxide in Selected Sites in Nairobi

Street	Concentration (mg/m^3)	
	Morning	Afternoon
Harambee	35	10.2
Muranga Road	22.4	-
Ronald Ngala	21.6	-
Kenyatta Avenue	22.3	-
Racecourse Road	18	-
City Hall Way	1.28	0.965
Monrovia Street	1.4	-
Sumba Street	2.2	-

Source: *Gatebe et al.*

Apparently, morning concentration is higher than afternoon. In comparison to WHO guidelines, some areas are non-attainment areas while others are close to non-attainment.

(iv) Hydrocarbons and Nitrogen Oxides

In a study reported in December, 1993, N0x and hydrocarbons were estimated for Nairobi hydrocarbons. The highest computed concentrations was 517 mg/m^3 on Moi Avenue during morning traffic peak. Other streets with high levels in comparison were as shown in **Table 3.8.**

The lowest values were for City Hall way 16.2 mg/m^3 and Parliament Road 33 mg/m^3. Moi Avenue had the highest computed afternoon concentration of 158 mg/m^3.

Table 3.7: Hydrocarbon Emissions in some Nairobi Streets

Street	Concentration (mg/m^3)	
	morning	Afternoon
Moi Avenue	517	158
Harambee Avenue	513	150
Kenyatta Avenue	360	1.95
Tom Mboya Street	370	141
Race Course Road	348	-
Parliament Road	330	-

Source: *Gatebe et al (1995)*

(v) Lead

In 1992, a study indicated that lead levels in Nairobi fall with WHO guidelines 0.5 - 15 mg/m^3. This lead comes mainly from motor vehicles.

3.2.8 Emission Reduction Techniques

If air quality standards are set without the development and implementation of measures directly aimed at emission reduction, the standards will fail to obtain clean air. Currently, various emission control methods or processes can be used, separately or together, to meet air quality standards.

a) Emission Control

The Public Health Act, assign a significant role to the height of smoke-stacks (the source of emissions) to reduce the ground level concentration of pollutants in the vicinity of plants. This measure is in itself economical and technologically simple. In most, but not all, meteorological conditions, it could effectively protect the environment around the plant. In recent years, however, heightened awareness about the problem of long-range transport of air pollutants and, in particular, the increasingly serious problem of acid deposition as evidenced at Thika due to Kel Chemicals Ltd, has turned the issue of stack height into a reason for concern rather than a method of control. Height of stacks without consideration to the nature and concentration of pollutants in place of emission control devices must today be considered an obsolete abatement mechanism for air pollutants.

b) Fuel Control

Specification of the characteristics of fuel, ash, or sulphur content, is an effective pollution control measure. Restrictions should be imposed on specific types of industries or in particular parts of Kenya especially with due regard to the synergism of the industries.

c) Technology Control

Control technologies have been tried in industries in Kenya. For example the Kenya Refineries Limited is able to reduce sulphur content in fuel. To what degree is not possible to know without consistent monitoring and enforcement of whatever standards will be adopted; however, it is true standards or no standards, emission abatement during combustion can effectively reduce sulphur and nitrogen oxides.

d) Use of Emission Limits

Emission limits can be defined as "the maximum amount of pollutant that is permitted to be discharged from a single polluting source", and also as the maximum admissible concentration of pollutant present in the fumes at the chimney outlet. Quantitative emission standards commonly fall into one of two categories: either an energy-input-related standard, such as nanogram of pollutant discharged per Joule of energy supplied to the plant (ng/J), or a standard expressed as a concentration of pollutant present in the flue gases, such as, milligrams of pollutant per cubic metre of discharge gas (mg/Nm^3)

In certain countries, emission limits are an integral part of environmental legislation, while in others they are set forth as *ad hoc* regulations. Emission limits are generally established according to classes of industry or types of plant. In certain cases, the trend is now emerging where the use of environmental guidelines are established when licensing is approved as part of plant specifications. As with the choice of air quality standards, the choice of emission control criteria also depends on the principles of environmental legislation of the country considered and may vary widely from one country to another. For example, the Organization for Economic Cooperation and Development (OECD) has recently prepared a broad review of the national emission limits and guidelines of its member states.

Oil Fuel Fired Boilers and Their Efficiency

Steam boilers are in the category of furnaces used for water evaporation. They are extensively used in industries for room heating, drying skins, degreasing tanks, in heat exchangers for oil heating, among others.

Majority of the industrial users of boilers use cost first and, then, production capabilities as prime criteria for the selection of such equipment while that factors such as energy management and environmental issues are normally relegated to minor roles. The high cost of fuel today together with the high rate of environmental degradation demands greater awareness of the management technics which should be incorporated in the designs of such plants.

In most applications of boilers heat is produced from the combustion chamber. The fuel is introduced into the combustion chamber at the burner, simultaneously mixed with air and ignited. The common fuel used are fuel oil, saw-dust, pulverized coke, and used oil. The heat transfer in the boiler, which could be categorised either as fire-tube boiler or water-tube boiler, takes place through a heat exchanger so that the product is not directly exposed to the combustion gases

The efficiency of the boilers depends greatly on the type of fuel used and by extension on the cost of the fuel. The selection of the fuels also depends on the type of burners employed. The burner system is designed to provide adequate mixing of fuel and combustion air with a flame shape as required by the combustion chamber design. Multiple burners may be installed to provide a temperature pattern within the boiler combustion chamber.

The appearance of the burner flame can be a guide to correct combustion conditions. Setting up the burner requires some experience. The appearance of the flame should be checked for future reference after an experienced boiler engineer has performed this task. In general terms, an oil flame should be a light brown or yellow colour. A short blow-torch shaped flame indicates too much air, whereas a long lazy smoky flame indicates too little air.

The quantity of fuel needed to generate a specific amount of heat depends on the heating value of the fuel. Heating value is the amount of heat generated when a fixed quantity of fuel is completely burned.

Combustion Air System

Stoichiometric air represents the amount of air required for complete combustion with the perfect mixing of the fuel and air. Stoichiometric air is some times called theoretical air. If perfect mixing is achieved, every molecule of fuel and air takes part in the combustion process. Excess air must be supplied to ensure complete combustion of the fuel and air does occur. Percentage excess air is defined as the total amount of combustion air supplied in excess of the stoichiometric air, expressed as a percentage of the stoichiometric air.

The minimum amount of excess air required varies with the fuel used and the efficiency of mixing the air and the fuel. If less than the minimum quantity of air is supplied, some of the fuel will not burn completely and there is a waste of fuel energy and emission of unwanted combustion products. Evidence of incomplete combustion usually shows up as CO in the flue gas. A continuous gas analyzer, can be used to check for CO in the fuel gas.

Too much air also wastes energy. The gases leaving the boiler are hot and contain heat energy. If excessive amount of are supplied to the boiler furnace, the excess will also be heated. The minimum losses occur when amount supplied is slightly greater than the stoichiometric amount.

Combustion air can be supplied to the chamber by natural or forced draft system. Natural draft uses the negative pressure (draft) produced by the furnace stack to draw combustion air into the furnace and the resulting flue gases out of the furnace.

There are several disadvantage related to natural draft firing. The amount of combustion air drawn into the furnace cannot be controlled accurately and the fuel air mixing is inefficient. This means that higher levels excess air must be maintained to ensure that complete combustion is achieved all conditions. The furnace pressure is always negative which allows air to leak into the furnace, and create additional flue gas volume and heat losses.

Forced draft firing uses a fan to supply combustion air to the furnace chamber. Air flow is regulated by use of dampers so that accurate control of the proportion of air to fuel for various firing rates is possible. A common method used to achieve this is to operate the fuel valve and the damper with a common mechanical linkage. Some of the adjustable cam is used to vary the relative positions of the fuel valve and the damper to provide proper fuel/air ratios at all firing rates.

The combustion air fan also provides better mixing of the fuel and the air. The air is introduced into the furnace chamber around the burners and turbulence can be created by vanes which produce a swirling motion in the air as it enters the chamber. A high pressure drop between the air supply and the furnace chamber is required to produce turbulence, and this can only be achieved with a forced draft system. These advantages mean that the excess air for a forced draft system can be lower than for natural draft firing, with resulting lower heat losses to the flue gas.

Flue Gases

a furnace in which heat is produced by the combustion of fuel can be considered to have fuel and combustion air as inputs, and flue gas as the output. Practically all fuels used in furnaces are hydrocarbons which contain the elements hydrogen and carbon. Although some fuels contain other constituents they are not usually important to the combustion process. The hydrogen in the fuel burns to form water vapour, and the carbon burns to form carbon dioxide (CO_2) , or a mixture of carbon dioxide and carbon monoxide (CO). Air contains nitrogen (N_2) as well as oxygen (O_2). The N_2 does not take part in the combustion process, except for the formation of small quantities of nitrogen oxides (NO_x).

The major constituents of the products of combustion are water vapour, CO_2, CO, N_2, and any excess O_2 left over from the combustion process. Not all of the constituents will be present in all instances. The presence of CO indicates incomplete combustion

Other Furnaces

Furnace emissions should not be limited to oil fuel fired boilers alone. In metallurgical process industries such as foundries and heat treatment plants, furnaces of various kinds are found. In foundries, melting of metals carries with emissions from elements lost due to overheating since all the constituents do not share common melting points. Likewise, the constituents do not share common melting points. Likewise the erosion of refractories together with other impurities form low melting point slug which float on the surface of the molten metal and contribute to the emissions.

Heat treatment furnaces also have their contribution of furnace emissions. Salt-bath furnaces using sodium cyanide as the carburising medium emit fumes to the atmosphere. The other furnaces in this category are pack carburizing furnaces, gas carburizing furnaces, and carbo-nitriding furnaces. Common metal treatment materials include gases such as hydrocarbon gas and ammonia.

It is therefore, important to consider regulations on fuel, set standards on the contents of emissions and guidelines for chimneys and smokestacks. These are proposed in Chapter 5.

3.3 Water

3.3.1 Water Quality

Water bodies can be fully characterised by the three major components, namely, hydrology, physico-chemistry, and biology. Under each component a large choice of variables can be used to describe the status of water bodies quantitatively. The factors determining water quality are thus complex, making it difficult to define water quality in simple terms. "Water quality" should, therefore, be considered to mean the overall quality of the aquatic environment (Chapman, 1992). The quality of the aquatic environment shows temporal and spatial variations due to factors internal and external to a water body.

3.3.2 Global Freshwater Quality Issues

Chemical water quality issues have evolved over the years with each stage of industrialisation. In the developed countries, the focus on water quality issues has shifted from

faecal, organic pollution and salinisation in the late 19th century to metal pollution, eutrophication and problems of radioactive wastes in the early to mid 20th century. During the last thirty years, problems of organic micro-pollutants (pesticide residues) and acid rain have become more important as water quality issues. In the developing world, the water quality issues have evolved more recently with the importance of each depending on the economic developmental stage and land-use of the country. The most important anthropogenic impacts on water quality, on a global scale, are summarised in **Table 3.8.**

3.3.3 State of Water Environment: Water Pollution in Kenya

Water resources in Kenya are increasingly becoming polluted from both point and non-point sources due to agriculture, urbanisation, and industry which contribute to organic, inorganic and aesthetic pollution of water. Ground-water is threatened by intrusion of saline water in the coastal region, leachates from solid waste dumps, and infiltration of fertilizer and pesticide residues. The five principal sources of water pollution in Kenya include, among others, the categories listed below, (JICA/GOK, 1992).

(a) Agricultural activities which produce sediments and agro-chemical residues (biocides and fertilizers).

(b) Industrial processing of agricultural and forestry products which produce liquid effluents, gaseous emissions and solid wastes.

(c) Industrial manufacturing - heavy metals, acids, dyes, oils.

(d) Domestic/municipal effluents – sewage and garbage.

(e) Sedimentation – soil erosion; and mining which produces tailings and effluents.

Table 3.8 Major Freshwater Quality Issues at the Global Scale

	Water body			
Issue	**Rivers**	**Lakes**	**Reservoirs**	**roundwaters**
Pathogens	xxx	x (1)	x (1)	x
Suspended solids	xx	na	x	na
Decomposable organic matter (1)	xxxx	xx	x	x
Eutrophication (3)	x	xx	xxx	na
Nitrate as a pollutant	x	o	o	xxx
Trace elements	xx	xx	xx	xx (4)
Organic micropollutants	xxx	xx	xx	xxx (4)
Acidification	x	xx	xx	o
Modification of hydrological regimes (5)	xx	x	x	
Salinization	x	o	x	xxx

Note:

xxx Severe or global deterioration found
xx Important deterioration
x Occasional or regional deterioration
o Rare deterioration
na Not applicable
(1) Mostly in small and shallow water bodies
(2) Other than resulting from aquatic primary production
(3) Algae and macrophytes
(4) From landfill, mine tailings
(5) Water diversion, damming, over pumping etc.

Source: *Meybeck and Helmer (1992)*

Municipalities and industries constitute the largest source of waste water discharges; however, industries discharge an enormous variety of wastes some of which are toxic to human beings and the general environment. Examples of such industrial wastes, which are a critical environmental issue in Kenya include effluents, sludges and solid waste from sugar, coffee pulping and textile factories, leather tanneries, paper-mills and slaughter-houses. **Table 3.9** gives the comparative strengths of waste waters from certain industries, while **Table 3.10** gives the waste water characteristics of some industries in Kenya.

All these wastes impact on water quality and are manifested through:

(i) deterioration of the quality of the aquatic environment, namely, deoxygenation, eutrophication, siltation, habitat modification and toxicity, among others;

(ii) environmental health effects with the occurrence of water-borne diseases, for example, typhoid and cholera, and chemical poisoning in humans and animals;

(iii) aesthetic effects leading to loss of scenic beauty with water becoming unsuitable for recreation;

(iv) high cost of water supply as polluted water is expensive to treat; and,

(v) water rights conflicts due to shortage of water of suitable quality for domestic, industrial and irrigation purposes. In order to protect Kenya's water resources from further degradation, water pollution or effluent discharge standards are necessary.

3.3.4 Water Pollution Control Guidelines/Standards Setting

In practice, standards can be set from either first principles or based on existing guidelines; international or national. For first principles, classification, and prioritisation of pollutants is necessary. Pollutant exposure processes and their ecological effects should be determined. Predicted environmental concentrations (PEC) and predicted no effect concentration (PNEC) for the aquatic environment should be derived. Usually, actual analytical data (baseline data) relevant to the locality or country situation are preferred.

Table 3.9 Comparative Strengths of Waste Waters from Industry[a]

Type of Waste	BOD_5 mg/l	COD mg/l	SS mg/l	pH Value
Tannery	1000-2,000	2000 - 4000	2000-3000	11 - 12
Brewery	850	1700	90	4 - 6
Dairy	600 - 1000	150 - 250[b]	200 - 400	acid
Slaughterhouse	1500 - 2500	200 - 400[b]	800	7
Pulp : Sulfite	1400 - 1700	84 - 10000	variable	-
Pulp : Kraft	100 - 350	170 - 600	75 - 300	7-9.5
Oil Refinery	100 - 500	150 - 800	130 - 600	2 - 6

a The values given here are from a wide number of sources, too numerous to quote.

b Permanganate value

Source: *Ciaccio (1971)*

Table 3.10: Effluent Characteristics of Some Industries in Kenya

Industry type	pH	BOD mgO_2/l	COD mgO_2/l	SS mg/l	Cr mg/l	S mg/l
Coffee: Pulping (1)	1800-9000	2950-14625	6200-11000			
Coffee: Fermentation and washing (1)	1200-3000	1650-2800	1950-4800			
Leather tannery (Raw) (2)	7.8-9.7	380-9000	675-12000	75-5000		
Leather tannery (Final) (2)	7.8-9.5	280-5000	500-6000	70-1000	3 - 6	1 - 10
Textile factory (raw) (3)	5.9-10.15	300-3000	600-910	65-140		
Textile factory (Final) (3)	7.9-10.3	320-400	460-600	24-80		

Note:

* Data for coffee processing with water recirculation

(1) Gathuo *et al.*, 1991.

(2) MWR - Departmental Records. Data are averages for 3 tanneries for the period 1987-1990

(3) MWR - Departmental Records. Data are averages for 2 textile industries for 3 years

BOD = Biochemical Oxygen Demand, five-day at 20°C
COD = Chemical Oxygen Demand
SS = Total suspended solids
Cr = Chromium
S = Sulphides as S

Standards can also be based on existing guidelines such as those of the International Standards Organisation (ISO) or other similar country standards. Baseline data collection is then undertaken to improve or adapt the initial standards to own country situation. Thus, baseline data is important for the setting of standards for water pollution as well as:

(a) forming a basis for zoning; where general or special standards should apply;

(b) assessing the assimilative capacity of various streams;

(c) identifying the water courses which require stringent or less stringent application of standards; and,

(d) formulating rehabilitation and/or conservation measures.

3.4 SOIL

3.4.1 National Standards

National standards on soil quality have not yet been developed. The National Agricultural Laboratories (later The Kenya Agricultural Research Institute, KARI) published a directory of methods of analysis of soil - Physical and Chemical Methods of Soil Analysis, 1980 Edition. This directory constitutes the first attempt to develop standardised methods of Soil Analysis in Kenya, but their use has been limited to analysis for agricultural purposes. In this directory methods of soil analysis have been classified into 4 categories.

(a) Physical Analysis, consisting of:

(i) Particle size analysis (mechanical analysis)

(ii) Soil Moisture Retention - the pF

(iii) Bulk density and porosity

(iv) Hydraulic conductivity

(v) Structure stability

(b) Mineralogical Analysis, consisting of:

(i) Clay mineralogy

(ii) X-ray diffractometry

(iii) Differential thermal analysis

(iv) Preparation of sand and mineral slides

(v) Free iron oxides

(c) Chemical Analysis, consisting of:

(i) pH: pH - Water

pH - KCl

pH - $CaCl_2$

(ii) Exchangeable acidity

(iii) Total nitrogen

(iv) Available phosphorus

(v) Available nutrients

(vi) Cation exchangeable capacity and exchangeable cations at pH 8.2 and pH 7

(vii) Soluble salts by electrical conductivity

(viii) Saturation extract

d) Special Analysis, consisting of:

(i) Available Fe, Mn, Zn and Cu

(ii) Total nutrients K, Ca, Mg and P

(iii) Total Si, Al and Fe

(iv) Calcium carbonate equivalent

(v) Gypsum ($CaSO_4$)

In the same edition, KARI has published a method for preparation of 1N solutions and for preparation of indicators. Although originally developed for soil analysis for agricultural purposes, these methods are used by various other soil testing laboratories.

The Ministry of Public Works in its Materials Branch has a laboratory devoted to soil analysis based on BS 1377 - 1990: British Standard Methods of Test for Soil for Engineering Purposes. This standard is not suitable for the analysis of soil for environmental quality purposes.

3.4.2 International and other National Standards

International Standards which have been developed and published that deal with soil quality are given in the ISO catalogue 1996. These standards have been adopted by many countries. For example, the British Standards Institution has developed and published a Standard on Soil Quality, namely, the BS 7755: 1990 - Soil Quality, Parts 3 and 4 on Chemical and Biological Methods. This standard is a direct adoption of the ISO Standards.

The Bureau of Indian Standards has also developed a number of standards on soil, the most significant of which is IS 2720 - Methods of Test for Soils. This testing is for engineering purposes although some of the methods would remain the same if the testing were for agricultural and other uses. The chemical methods of test in this standard are similar to those in use at KARI.

Table 3.11: Physical and Chemical Methods of Soil Analysis - KARI, July 1980

METHOD	BRIEF DESCRIPTION OF PRINCIPLE	MATERIALS/REAGENTS REQUIRED	APPARATUS REQUIRED	RECOMMENDATIONS
1. Determination of pH of soil suspension	By measuring the hydrogen - ion concentration of aqueous solution/suspension	De-ionized or distilled water - 1 M KCl - 0.01 M $CaCl_2$ - pH meter	- Plastic shaking - Bottles - Mechanical reciprocal shaker The technology used is similar to that employed	in ISO Standard. This method and the ISO Standard ISO 10390: 1994 used as references for a Kenya Standard on the subject.
2. Determination of exchangeable acidity (Permanent charge acidity)	Leach soil with Barium Chloride solution for Ba^{++} ions to replace H^+ and Al^{3+}. The amount of NaOH needed to restore the pH of the Barium Chloride solution is equivalent to the amount of hydrogen and aluminium exchanged	- Barium Chloride 0.6 N - Sodium Hydroxide 0.05N - Phenolphthalein, 1%	- Mass balance of 0.0001 g accuracy - Burette - pH meter - volumetric flasks - Volumetric flasks - Filter funnel & Filter paper - Measuring cylinder	The technology employed is available in Kenya. This method and the ISO Standard, ISO 11260: 1994 may be used as references for National Standard.

METHOD	BRIEF DESCRIPTION OF PRINCIPLE	MATERIALS/REAGENTS REQUIRED	APPARATUS REQUIRED	RECOMMENDATIONS
3. Determination of organic carbon Heat mixture of soil	sample, excess potassium dichromate with Sulphuric Acid	- Potassium dichromate 1 N - Ammonium ferrous sulphate 0.5 N - Diphenylamine indicator - Orthophosphoric Acid 85% - Sulphuric Acid 96%	- Ordinary laboratory glassware - mass balance accurate to 0.0001 g	The principle used, the apparatus used and the reagents are similar to those used in ISO 10694. This method and the ISO Standard may be used as references for a Kenya Standard.
4. Determination of nitrogen	The method is based on the Kjeldahl digestion using Selenium as the catalyst - Sulphuric Acid 96%	- Selenium mixture - Sodium Hydroxide 46% - Boric acid 1% - Mixed indicators solutions - Boric acid - indicator solution - Sulphuric Acid	- Digestion apparatus - Stem distillation apparatus - Ordinary laboratory glassware - Stop watch - Agate mortar - Sieve, 0.5 mm	This method is similar to ISO 11262: 1995 in which Titanium Dioxide is used as the catalyst. The method in combination with this ISO Standard are suitable for use as references for a Kenya Standard on the subject
5. Determination of available phosphorus	Soil is extracted with 0.5 M sodium Hydrogen Carbonate at pH 8.5. Phosphorus in solution, is determined calorimetrically as a blue phosphomolybdic complex reduced by a reagent comprising Sulphuric Acid, Ammonium Molybdate, Ascorbic Acid and Potassium Antimonyl Tartrate	- Sodium hydrogen Carbon solution 0.5 M - Sodium Hydroxide, 1 N - Sulphuric Acid, 5N - Ammonium Molybdate 4% - Ascorbic acid, 0.1 M - Potassium Antimonyl tartrate - Stock phosphate solution 100 ppm P - Standard P solution, 10 ppm - P standard series	- Spectrophotometer - Calorimeter - Mass Balance accurate to 0.0001 g - pH meter - Reciprocal shaker - Ordinary laboratory glassware	This method is identical to the method of ISO 11263: 1994: The method together with this ISO Standard are suitable for use as references for a Kenya Standard on the subject
6. Determination of Sulphate	Sulphate ions are measured calorimetrically. Add Barium Chloride to a solution containing sulphate ions. A white Barium Sulphate compound is precipitated. the turbidity is used as a measure of the sulphate concentration.	- Barium Chloride $BaCl_2$ - Gum Acacia 0.5% - Sulphate Standard solutions	- Calorimeter with curettes and a blue filter - vortex mixer	This method is very similar to that employed in ISO 11048. The technology used is the ISO Standard is also easily available in Kenya. It is recommended that this KARI method and the ISO Standard be used as references for a Kenyan Standard
7. Determination of $CaCO_3$ equivalent (Scheibler)	Soils containing carbonates produced CO_2 when treated with HCl. If the amount of gas is compared with the volume of gas developed by a known amount of $CaCO_3$, the amount of carbonate in the soil can be calculated	- Distilled or deionized water - Hydrochloric Acid 25% - $CaCO_3$ powder	- Reciprocal shaking machine - Water manometer with tubes connecting to shaking bottles - Shaking bottles - Ordinary laboratory glassware - Mass balance accurate to 0.005 g	This method is identical to the method in ISO 10693: 1995. The method in combination with that in this ISO Standard are recommended for use as references for a Kenya Standard on the subject

METHOD	BRIEF DESCRIPTION OF PRINCIPLE	MATERIALS/REAGENTS REQUIRED	APPARATUS REQUIRED	RECOMMENDATIONS
8. Determination of the Electrical Conductivity of the Saturated Extract	By measurement using a Conductivity Meter - Calcium Sulphate	- Super saturated solution ($CaSO_4$)	- usual laboratory glassware - Conductivity Meter - Conductivity Cell, pipette type for small volume - Thermometer (room temperature)	This method is similar to that in ISO 11265. The technology employed in both methods is equivalent and easily available in Kenya. The two methods are recommended for use as references for a Kenya Standard on the subject
9. Determination of available nutrients: P, Mg, Mn, Ca, K and Na	Soil is extracted with a mixture of 0.1N HCl and 0.3N H_2SO_4. The acid serves to replace the bulk of the exchangeable metal cations and the Sulphate anion is exchanged for phosphate. The first three elements are determined calorimetrically and the last three by flame photometry	- 4 N HCl, IN H_2SO_4 - 0,1 N HCl 9,25N H_2SO_4 - Ammonium Vanadate - Ammonium Molybdate - Magnesium compensating solution - Sodium Hydroxide, 8% - Phosphoric Acid - Potassium Periodate - Brucine, 4% - Sulphuric Acid 14 N - Activated Charcoal - Hydrochloric Acid 10% - $AgNO_3$, 5% - Anion exchange resin, De-Acidite E - Ammonium Hydroxide 2N - Phenolphthalein indicator - Aluminium Chloride, 5%	- Mass balance accurate to 0.001 g - Usual laboratory glassware - Mechanical shaker calorimeter - Flame Photometer with Ca, Na and K filters - Vials with plastic caps, 25 ml and 10 ml - Filter paper, Whatman No. 2	This method and the ISO Standards 11260 and 13536 may be used as references for Kenya Standards for the determination of P, Mg, Mn, Ca and K concentration in soil. In the ISO Standards, Barium Chloride is used. The Standards contain a warning on the handling of Barium Chloride due to its toxicity and potential to harm the environment.

Table 3.12: Chemical and Biological Methods of Analysis not available in KARI Publication - ISO Standards

METHOD	BRIEF DESCRIPTION OF PRINCIPLE	MATERIALS/REAGENTS REQUIRED	APPARATUS REQUIRED	RECOMMENDATIONS
1. ISO 11465 - Soil Quality - Determination of dry matter and water content on a mass basis by a gravimetric method	Soil samples are dried to a constant mass at 105°C±5°C. the difference in mass of an amount of soil before and after the drying procedure is used to calculate the dry matter and water contents on a mass basis	- Nil	- Drying oven, thermostatically controlled with forced air ventilation and capable of maintaining a temperature of 105°C±5°C. - Desiccator, with an active drying agent - Analytical balance accurate to 10 mg - Container (Moisture box) with lid, capacity 25 ml - 100 ml	This is an easily adapted method in most laboratories in Kenya. This ISO Standard is recommended for use as a reference for a Kenya Standard

METHOD	BRIEF DESCRIPTION OF PRINCIPLE	MATERIALS/REAGENTS REQUIRED	APPARATUS REQUIRED	RECOMMENDATIONS
2. ISO 112680-1- Soil Quality - Effects of pollutants on earthworms (*Eisenia fetida*) Part 1: Determination of acute toxicity using artificial soil substrate	The percent mortality of adult earthworms placed in a defined substance containing the test substance in different concentrations is determined after 7 days and 14 days. The results contained from these tests are compared with a control and used to estimate the concentration which causes the mortality of 50% of earthworms	- Biological material earthworms at least 2 months old with a clitellum and a wet mass between 300 mg and 600 mg - Test substrate artificial soil	- Usual laboratory equipment - Glass containers 1 litre, 2 litres	This is an easy test to adopt in laboratories in Kenya. The ISO Standard is recommended for use as a reference for a Kenya Standard
3. ISO 11269 - Soil Quality - Determination of the effects of pollutants on soil flora. Part 1: Method for the measurement of inhibition of root growth	Growth of regerminated seeds under controlled conditions for a set period depending on the test plant. Control media are soil and sand. After the growth period measurements of the length of roots from both controls and unknown soil or substance under test. These are compared.	- Test plants - Growth media	- Pots	The method is simple and easy to use in laboratories in Kenya. The ISO standard is recommended for use as a reference for a Kenya Standard
4. ISO 11269 - Soil Quality Part 2: Effects of chemicals on the emergence and growth of higher plants	This plytoloxicity test is based on the emergence and early growth response of a variety of terrestrial plant species to various concentrations of a chemical added to the test soil. The emergence and MASS (dry or fresh basis) of the shoots of the test plants are compared with those of the control plants	- Test plants - Test soil - Polluting chemical	- Phytotrons, plant growth rooms or greenhouses - Non porous plastics or glazed pots, internal diameter 85 mm - 95 mm	This method is simple and easy to use in laboratories in Kenya. The ISO standard is recommended for use as a reference for a Kenya Standard
5. ISO 11466 - Soil - Quality - Extraction of trace elements soluble in aqua regia	The dried soil sample is extracted with a hydrochloric/nitric acid mixture by standing for 16hr at room temperature followed by boiling under reflux for 2 hrs. The extract is then clarified and made to volume with nitric acid. The trace element content of the extract can then be determined.	- Water - Hydrochloric acid 12 mol/litre - Nitric acid 15.8 mol/litre - Nitric acid 0.5 mol/litre - Usual laboratory glassware	- Grinding mill - Test sieve, 0.15 mm - Desiccator, 2 litres - Reaction vessel 250 ml - Reflux condenser - straight - through type, with conical ground- glass joints	The method is simple and easy to use in laboratories in Kenya. This ISO standard is recommended for use as a reference for a Kenya standard

3.4.3 International Standards on Soil Quality Currently under Preparation

The following ISO Draft Standards are still under consideration and when they are published as ISO Standards, consideration should be given to combining them with available local methods to develop Kenya Standards:

ISO DKS 11259	-	Terminology.
ISO DKS 10381	-	Guidance on the design of sampling programmes.
10381-2	-	Guidance on sampling techniques.
10381-3	-	Guidance on safety.
10381-4	-	Guidance on the procedure for investigation of natural, .near natural cultivated sites.
ISO DKS 14507	-	Pretreatment of samples for the determination of organic contaminants.
ISO DKS 14254	-	Determination of exchangeable acidity.
ISO DKS 14870	-	Extraction of mobilizable and mobile element fractions.
Part 1:	-	Extraction of Cadmium Chromium Copper, Iron, Manganese, Nickel, Lead and Zinc by PTPA

CHAPTER 4

4.0 CLASSIFICATION AND PRIORITISATION OF ENVIRONMENTAL ISSUES

4.1 Air

4.1.1 Sources of Air Pollution

In the cities and towns especially the working environments, the major pollutants are chemicals, unburnt hydrocarbons, lead and nitrogen oxides, noise, fumes and miscellaneous gases. Air pollution levels are determined by the social, economic and technological factors as well as, the capacity of the country to enforce its laws which have an impact on the environment.

In Kenya anthropogenic sources of air pollution in order of distribution of pollution are land-use, transport, animals/ agriculture, mining and transport of mined products; solid waste disposal, building and construction; industries and electrical energy generation.

In order to put air pollution issues into perspective, sources are referred to as:

(i) stationary sources, that is, energy generation, industries, and public services; and,

(ii) on mobile sources, such as motor vehicles, trains, aeroplanes, among others.

4.1.1.1 Stationary Sources

The major sources of gaseous emissions in this category are energy generation and industries.

Energy Use

Energy sources are grouped as biomass (wood, animal waste, agricultural residue etc), fossil fuels (natural gas, petroleum), electricity generation, nuclear and solar energies. The latter two are not important as far as air pollution is concerned.

(i) Biomass Burning

Approximately 96% of the total quantity of energy consumed in Kenya is provided by the woody biomass (mostly fuelwood). It is used for household heating, cooking, and lighting. In many cases it is used for commercial and industrial energy requirements and charcoal production. The current wood requirements (1995) are 7,992.9m^3 as firewood and 5,087.7m^3 used for charcoal giving a total of 13,080.6m^3. The average consumption is 0.5 x 10^3m^3 of wood per person per year. This figure is set to double by the year 2020, although the *per capita* consumption may not change. This is expected since over 75% of total consumption is for household purposes and should closely follow the rate of increase of the rural population. Over the period 1981 to 1992 (inclusive) household consumption of fuelwood represented the largest use category at 75% followed by commercial consumption (10.5%) then charcoal 60%.

This estimate is an underestimated since most of the supply comes from outside scheduled areas where no are records kept. In normal cases it has been discovered that a home of 5 people on average uses 39.64m^3 of fuelwood per year or 7.92m^3 per person. This would represent 20kg of firewood per day and 2.5 kg of charcoal for cooking meals.

Emissions Related to Biomass Burning

The importance of wood to air pollution cannot be underestimated. For the case of households, dispersion of combustion gases is not controlled. People are exposed to these gases. In general, indirect fuel boilers, as in industrial activities and institutions, have separate stacks for the gaseous by-products of combustion such as oxides of nitrogen.

Technology of Wood Burning

Wood fuels for ovens, grills, barbecues may release particulate matter. The amount of oxides of nitrogen produced depends on the combustion temperature, the higher the temperature, the more oxides of nitrogen. In households, the main combustion is through open fire wood stoves, charcoal-stoves and ovens. Besides wood, the same facilities may burn bio-waste, and in very limited cases, biogas. These are not discussed in detail here. In many cases, boilers and furnaces are used to generate energy.

Emissions Related to Wood Burning

The technology applied is important in determining whether the carbon content will leave as the "harmless "carbon dioxide or as carbon monoxide, particulate and soot. In most cases boilers are used.

Table 4.1 Emission Factors (Kg/TJ) from Various Sources

Source	CO	CH_4	NO_x	N_2O
Wood pits	4,949	200	147	N/a
Wood fireplaces	6,002	N/a	116	N/a
Wood stoves	18,533	74	200	N/a
Propane	10	1.1	47	N/a
Commercial				
Wood Boilers	199	15	33	43
Gas Boilers	9.6	1.2	48	2.4
Residual Oil Boilers	17	1.6	155	46.5
Open Burning	42	-	-	

Source: *Intergovernmental Panel on Climate Change(IPCC) Guidelines for National Greenhouse gases.*

From the **Table 4.1** it is apparent that wood pits and fire places are the largest generators of carbon monoxide and it is important to remember that the bulk of Kenya rural homes use firewood as the main source of heating and lighting, thus exposing them to large concentrations of carbon monoxide.

(ii) Electricity Generation

Electricity is often referred to as clean energy. Its generation, however, sometimes does not warrant this tag. The main modes of generating electricity in Kenya are hydro-electric power plants, thermal, gas turbines and geothermal. Many premises also have diesel fuelled generators used only when there is a power failure or when there is a voltage drop. Generators, unless continuously used, do not generate serious pollution problems except at a local level. In this report, only the bigger generation of electricity is considered.

Table 4.2 summarises the peak power capacity of the power generation system for hydro, thermal, gas turbines, and geothermal within the country for the period 1990/91 to 1994/95 and also lists the projected demand.

Table 4.2: Dependable Power Generation Capacity and Energy Balance Projections (megawatts)

Source	1991/92	1992/93	1993/94	1994/95
Hydro	417.6	460.4	417.6	460.4
Thermal	96.5	96.5	96.5	96.5
Gas turbines	42.0	42.0	42.0	42.0
Geothermal	43.2	43.2	43.2	43.2
Total	599.3	642.1	599.3	630.1
Expected Peak Demand	589.0	620.0	653.0	687.0
Surplus/ deficit	+10.3	+22.1	-53.7	-56.9

Source: *Kenya Power Company, March, 1994*

The next is thermal, contributing 16%, gas turbines 7%, and geothermal 8%. Hydroelectric power generation has no significant air pollution effect, while geothermal power stations are currently in remote locations generating mainly hydrogen sulphide and carbon dioxide as the main gaseous emission. Therefore, the thermal and gas turbines generate 24 % and are the main sources of air pollution mainly because of the use of petroleum products.

(iii) Petroleum Products

Fossil fuels are imported into Kenya either as crude oil or refined products. Refined petroleum products are converted through combustion to various gases. Crude oil normally is 3% sulphur which is converted to SO_2 at the refinery and emitted into the atmosphere. Refined products do not have this problem. It can be assumed that all the SO

emanating from crude oil refinery is emitted in the environs of the Kenya Oil Refinery at Mombasa.

Table 4.3 shows the trend of the types of petroleum finished products of fuel imported to Kenya in the 1990-94 period while **Table 4.4** shows the sectors in which they are used. All except bitumen are at one point or another is converted to gaseous products. Out of this, the use of Jet/Turbo fuel can be deemed to be used outside the direct exposure of people. All others are used within the corridor of the developed section of Kenya while the use of petroleum and diesel will be discussed under the section on motor vehicles.

Table 4.3 Import of Petroleum Products and its Conversion to End Products

Product	Quantity ('000 tonnes)
Liquefied petroleum gas	27.4
Motor gasoline (premium	153.0
Motor gasoline (regular)	176.4
Illuminating Kerosene/jet Turbo fuel	425.9
Light Diesel oil	500.3
Heavy diesel oil and Marine diesel oil	29.2
Fuel oil	499.6
Export Residues	164.1
Intermediates	9.4
Refinery usage	101.3
Total	**2,092.2**

Source: *Economic Survey, 1995*

Table 4.4 Sectoral Use of Petroleum Products

User Sector	Tonnage ('000)
Agriculture	70
Retail pump outlets and roads transport	870
Rail transport	32.5
Tourism	12.3
Marine	165.9
Aviation	355.0
Power Generation	41.5
Industrial Commercial and others	407.9
Government	36
Total	**1,826.2**

Source :*Economic Survey, 1995*

It is important to single out illuminating kerosene oil as belonging to the category of products under household use alongside wood-fuel. Kerosene when burned gives carbon monoxide, carbon dioxide, particulate matter, sulphur dioxide, volatile organic compounds, methane and nitrogen oxides. The other use is as jet fuel. In both cases, the dispersion of the resultant emissions is not controlled and, therefore, are widely dispersed from these non-point sources.

(iv) Selecting Priority Pollutants from the Energy Sector

Power generation uses 41.5 thousand tonnes of petroleum products while industrial, commercial, and other uses account for 407.9 thousand tonnes or ten times as power generation.

Hence, electricity generation and industries are the major stationary sources of air pollutants. It can be assumed that the oil in industries is used in the boilers described earlier. Residue fuel oil produces nitrogen oxides, particulate, and sulphur oxides as the main pollutants, in that order. In this regard the priority pollutants are NO_x, and to a lesser extent, carbon monoxide.

Some of the industries that use energy extensively are:

- inorganic chemical factories such as those of sulphuric acid and sulphonic acid;
- Iron and steel foundries and galvanising plants;
- paper mills;
- tea factories; and,
- cement production factories.

From the above considerations, emissions from energy sources include CO_2, CH_4, N_2O NO_x, NMVOC and CO. Each of these gases jointly or singly is important to global environment, health and welfare. Of these only CO_2 can be estimated from energy data with some degree of accuracy. Emissions of all the other gases depend on many factors including combustion conditions, technology and emission control. Hence, concentrations of the gases need to be scientifically monitored by taking actual measurements.

4.1.1.2 Industries

Industries are major sources of air pollutants due to their intensive use of fuels. In this section, focus is on pollutants other than those associated with energy generation mainly from industries.

(i) Chemical Industries

Chemical industries are essential for the formation of a strong and sustainable industrial base. They are also vital in forging the necessary linkages between industry and the agricultural, transport and communication sectors. Those that are likely to have significant gaseous emissions are as listed below:

- Metallurgical industries relted to iron and steel production which provide a wide range of materials required by the engineering industry. This industry is important in recycling metal chemical containers which release highly volatile compounds.

- Chemical and bio-technological industries that provide fertilizers, pesticides, industrial process chemicals and packaging materials relevant especially to agriculture and food production. The industries release persistent organic products in gaseous form.

- Pharmaceutical industries for the production of medicinal drugs and vaccines which release complex chemical formulations.

- Agro-industries such as power alcohol generation.

Priority Pollutants in Chemical Industries

The major source of gaseous emissions from industries is from solvent use, energy generation, servicing and maintenance. Chemical industries are judged as hazardous due to the volatility of the chemicals they use. Solvents are commonly used in engineering workshops, dry-cleaning units and cosmetic industries. They are commonly referred to as Non-Methyl Volatile Organic Chemicals (NMVOC) to distinguish them from the volatile hydrocarbons such as kerosene and liquid petroleum gas.

In many cases NMVOCs are chemical cleaning substances used in dry-cleaning, printing, metal degreasing and a variety of industrial applications as well as household use. Also included in this category are paints lacquers, thinners, and materials used in coating in a variety of industrial, commercial and household applications.

Gasoline blending additives such as methanol, ethanol and methyltetrabutylethanoate (MTBE); and chemical feed-stock, for example, propylene, ethylene and naphthalene also occur in air emission. Additives and chemical feed-stock are, for the most part, released as air emissions due to their high volatility. Usually the emissions are in small quantities likely to affect the working environment but some like chlorinated hydrocarbons have been known to be deplete the ozone layer.

(ii) Rubber and Plastics Industry

Rubber and plastics industries are major sources of VOCs. There are about 100 manufacturers of plastic products in the country. Almost all the raw materials are imported; however, there are also two plants that recycle plastic wastes. These generate many organo-chlorine compounds such as vinyl chloride which are carcinogenic.

The top ten chemicals released by the rubber and miscellaneous plastic industries are 1,1,1 trichloromethane; acetone; carbon disulphide; dichloromethane; methanol; methylethylketone; styrene and xylene. They are suspect in areas where chemicals are heated to vaporisation temperature during operations or during open air burning.

(iii) Paper Mills Industry

Pulp mills processes emit gaseous wastes as part of the manufacturing process. The typical odour of Kraft pulp mill is due to the presence of sulphur in the boiling liquor which is responsible for the production of hydrogen sulphide, methyl mercaptan, methyl disulphide, and sulphur dioxide gases. In some mills, other additional emission types may come from auxiliary operations. At the Pan Paper Mills in Webuye, for example, chlorine is released from chlorine washer tower as well as from the caustic soda/chlorine generation plant. The sources of these gases are as follows:

- blow tank vents of the batch digester plant;

- seal tank vents of brown stock washing plant;

- recovery boiler and lime mud reburning kiln stack;

- smelt dissolving tank vent stack;

- vent from hot well (foul condensate tank) in evaporation plant;

- vent from bleach plant (washers and bleach towers); and,

- leakages from caustic soda/chlorine plant.

Apart from the odorous gases, the particulate matter are emitted from the stacks of bark boiler, recovery boiler, and lime-mud reburning plant. Dust carry-over in the flue gas from the recovery boiler is collected in three electrostatic

precipitations and back to the system. Similarly, the dust carry-over from the kiln is scrubbed in a venturi scrubber with mill water and fed to clarifiers for the separation of sludge which is fed into the system. It, therefore, becomes difficult to pinpoint, in the factory, the actual stack that is emitting fugitive gases.

The pulp and paper industry releases 87% of its total toxic emissions into the atmosphere; approximately 10% to water, and 2% is transferred to site or disposed of on land.

Air releases can be traced to a variety of sources. Approximately 50% are methanol, a by-product of the pulp making process. The other major toxic chemicals emitted include chlorinated compounds, sulphuric acid and the chelator methylethylketone, originating from the bleaching stage.

The priority pollutants are particulate matter, total reduced sulphur (TRS) and NMVOC.

(iv) Cement and Excavations

There are three cement plants in Kenya whose combined production capacity is 1.55 million tonnes per year while actual production is about 1.4 million tonnes per year. Domestic consumption of cement is 1.1 million tonnes per year leaving a surplus of 0.3 million tonnes for export. The main raw materials for cement production are limestone, pozzuolana, and gypsum and are available in adequate quantities in various parts of the country. The main pollutants are dust particulates, grit and dust.

(v) Ceramic Tiles

There are three ceramic plants producing crockery, wall tiles, and sanitary ware. The basic raw materials such as silica sand, kaolin, Kisii soapstone, quartz, among others, are locally available. The main pollutants are dust particulates, grit and dust.

(vi) Glass Factories

There are three glass container manufacturing plants in the country. The country imports the larger containers. The basic raw materials for glass manufacture such as soda ash, silica sand, sodium sulphate, and fluorspar are locally available.

The Central Glass Industries in Ruaraka is the largest container glass industry in Kenya, which is located in a heavily residential area and currently a major concern to residents in as far as air pollution is concerned. The main pollutants are sulphur oxides, NMVOC, carbon monoxide, dust and particulates.

Working with the raw materials of the above industries exposes one to respiratory diseases, digestive disorders, skin diseases, rheumatic and nervous conditions, hearing, and vision disorders.

(vii) Excavations

The building and construction industry including harvesting and transport of building materials is a major source of particulate releases to the atmosphere.

Typical activities in this area include sand harvesting, transport and storage; stone crushing and dressing, quarry blasting and construction.

Sand harvesting presents a peculiar source of pollutants since it depends on where the sand is mined. The sand from the coastal and Machakos areas has heavy grains which are not easily airborne .Volcanic sand used in the central region of Kenya and mined around Mt. Longonot, however, has got finer grains which are easily air-borne with possible negative impacts to the environment.

In related activity, there is extensive crushing of stone in road gravelling which produces fine dust which is also easily air-borne.

Particulate matter is emitted from sand and gravel operations and is made up principally of inert crystal material, for example, soil and rock particles. Dust emissions in the form of fugitive dust occur during removal of over burden, sand and gravel from the deposit, wind-blown dust from storage piles, from transport, during material dumping from trucks, front and leaders, and conveyors from screening. The amount of moisture affects the amount of dust emissions that occur. In Kenya the deposit is dry and the material have high silt content and usually dust emissions are significant.

This is an area where standards are difficult to formulate. Emissions can be reduced by various technological innovations. They include:

- using water sprays to keep materials wet;
- limiting drop heights of materials;
- covering lorries;
- using enclosures or holding materials at transfer and handling points; and,

- exhausting air from these points to air pollution control systems.

The priority pollutants are dust and particulate, carbon monoxide, and hydrogen sulphides.

(viii) Tanneries and Leather Industry

Leather tanning industry uses many types of chemicals which, when they react together, emit hazardous and offensive smells such as hydrogen sulphide in addition to generating other toxic chemicals and hazardous wastes. The Government has put in place a number of programmes aimed at reducing chemical risks, strengthening management of hazardous wastes, and maximising environmentally sound waste re-use and recycling. Special incentives were given in the national budget speech of 1994, to encourage tanneries to set up effective effluent disposal plants to overcome the present pollution problems. The Kenya Industrial Research and Development Institute is carrying out research in treatment of tannery waste which would reduce air pollution associated with tanneries.

Priority Pollutants are NMVOCs and hydrogen sulphide. **Table 4.5** summarises the type of air pollutants expected from industry.

Table 4.5 Summary of Air Pollution Parameters and Tolerable Standards

INDUSTRY	AIR POLLUTANTS FROM SOURCE	REGULATABLE PARAMETERS	TOLERANT VALUES (TLV) IN PPM
1. Aluminium Industry	CO; SO_2 as dust	CO, SO_2	50, 5
Cane sugar mills	dust, CO, SO2, CO	CO, HCl, CO_2, Dust	55, 7, 13, 10, respectively
Cement	Dust	Dust	10
Foundries	Metal fumes	CO	55
	Metal dusts	Fluorides	2.5
	Fluorides	Chlorine	3
Iron and Steel Foundries.	Dust	Iron Oxide Fine	5
	Metal fumes	Lead	50
	Metal dusts	Magnesium	5
		Zinc Oxide	5
Grain Handling	Grain dust Methyl Bromide	Grain dust	15
	Phosphine	MeBr	80
	Carbon tetrachloride	Phosphine	0.4
	Carbon disulphate	CO_2	60
Lead Smelting	Lead	Pb	
	Arsenic and Compound	As	10
	Copper fumes	Cu	0.2
	Copper, dusts and mists	Cu (dusts)	1.0
	Silver metal	CO	55
Non ferrous mining	Carbon monoxide	CO	55
	Nitrogen Dioxide	NO_2	9
	Hydrogen Sulphide	H_2S	15
	Hydrogen Cyanide	HCN	11
	Sulphur Dioxide	SO_2	13
	Dust	Dust	0.5
Power Plants and fuel oil	Sulphur Dioxide Carbon	SO_2	13
	Monoxide	CO	55
	Nitrogen Dioxide	NO_2	9
	Dust		
Pulp and Paper	Wood Dust	Wood dust	5
	Sulphur Dioxide	SO_2	13
	Chlorine	Cl_2	3
	Chlorine Dioxide	ClO	0.3
	Ammonia	NH_3	18
	Phenyl mercuric Hydrogen	PhHgAc	0.1
	Sulphide	H_2S	15.0
PVC Processing	Vinyl Chloride Monomer..	vinyl chloride	<1
Sawmills	Dust	TSP	<5
Slaughterhouses	Dust	TSP	Absence of odours
Sulphuric Acid Plants	Sulphur Dioxide	SO_2	100 Annual Mean 1000mg/m^3 24hrs Peak

Sources: *See references*

4.1.1.3 Mobile Sources

Under this category fall the following emission sources:

- marine and inland water transport (ships plying Lake Victoria) ;
- rail transport;
- Road transport; and,
- Air Transport.

Marine and Inland transport

This category includes ships and boats plying the territorial and international waters. International marine vessels have to comply with emission regulations of all the countries they visit. Standards for marine vehicles are not proposed due to difficulties in enforcement. There are, however, vessels cris-crossing Lake Victoria and calling on Ports in the East African region for which emission guidelines will have to be developed at a later stage.

There has not been a record of complaints of air pollution emanating from marine sources and it is proposed that this is deferred to a later date.

Rail Transport

The main sources of air pollution in this mode of transport are the predominantly diesel-fuelled locomotives which normally are restricted within the national boundaries, but with the current regional cooperation, the locomotives my start go beyond national borders.

The rail mode of transport has not been traditionally regulated by main-stream regulatory agencies ostensibly because being government institutions they are supposed to self-regulate; however , there is no documentary evidence to show that this is done.

Road Transport

Estimation of mobile source emissions from road traffic is a very complex undertaking that requires consideration of factors such as transport class, fuel consumed, operating characteristics, emission controls, maintenance procedures and fleet age. **Table 4.6** gives an indication of transport vehicles, and the estimated emissions by type; while **Table 4.7** gives the estimated number of vehicles in Kenya.

Table 4.6:Vehicles and the Type and Quantity of their Emissions

Type of vehicle	Assumed Fuel Economy km/litre	CO_2	NO_x	NMVOC	CO	N_2O	Particulates
1.Passenger cars	5.1	3188	6.05	3.09	6.29	0.08	0.06
2. Light Duty Diesel Trucks	4.3	3188	7.17	4.11	7.96	0.08	0.10
3.Heavy Duty Diesel Vehicles	2.2.	3188	42.86	7.63	21.80	0.08	0.26
Motor cycles	12.8	3172	3.2.3	111	405	0.08	5.6

Source: *IPCC (1991)*

Table 4.7: Vehicles with current Licenses

Type of Vehicle	1989	1994
Motor cars	171569	
utilities, Panel vans, Pick-ups etc	83,400	100,178
lorries, trucks and heavy vans	31,183	32,413
buses and minibuses	12,006	29,681
Motor and auto cycles	22,347	32,3177
other motor cycles	22,347	23,843
Trailers	13,533	10,571
Total	334,808	398,204

Source: *Kenya Economic Survey, 1996*

Types of Emissions from Road Transport

In Kenya, there are no emission controls on many vehicles. **Table 4.6** gives an estimate of the type and kind of emissions from various vehicle sources based on the assumption that there are no emission controls. The IPCC classification is adopted for simplicity and uniformity. It must be borne in mind that in Kenya, the level of vehicle servicing age, type of roads and modes of driving are such that the assumed fuel economy is unrealistic.

Also it must be borne in mind that transit heavy haulage vehicles are not accounted for and as Kenya is a major transit corridor for vehicles to Rwanda, Burundi, Uganda, Eastern Zaire and even parts of Tanzania and Sudan , the level of emission must be far much higher than the IPCC inventory system.

4.2 Water

4.2.1 Water Pollutants

The pollutants which enter water bodies are most commonly contained in effluents derived from a wide range of human activities, as a result of soil erosion, accidental spills or illegal dumping. Nine groups of pollutants in two categories can be identified (JICA/GOK, 1992).

Physico-chemical pollutants:

- Organic residues, such as, sewage, brewery wastes.
- Inert suspensions - soil sediment, mine wastes.
- Toxic wastes - heavy metals, pesticides.
- Fertilizers and detergents.
- Inorganic reducing agents - sulphides, sulphites.
- Petroleum products - waste oil, tanker spills.
- Heat.

Biological pollutants:

- Micro-organism - faecal coliforms, cholera bacilli.
- Macro-organisms - parasitic worms, exotic fish species and aquatic weeds.

In Kenya, today the main pollution problems are caused by organic residues, suspended matter, toxic wastes, and the biological pollutants. Fertilizers and detergents are increasingly becoming important. The in-organic reducing agents, petroleum products and heat are not yet a big problem but may become so as industrialisation proceeds. Some problems with oils disposed of in public sewers, however, are being experienced in places such as Kisumu.

4.2.2 Prioritisation of Variables to be Standardised

Priority Uses of Water

Pollution and the consequent water quality degradation interfere with vital and legitimate uses of water, and general environmental health. Some types of water uses are more prone to be affected than others.

Water quality criteria, standards and the related legislation are used as the main administrative means to manage water quality in order to achieve user requirements. The most common national requirement is for drinking water of suitable quality; however, the number and specification of variables standardised have a technical and economic implication on the country. It is, therefore, not practical to standardise all variables at once. Hence, it is necessary to prioritise the variables based on their impact on the water resources and key uses of the water resources, viz., domestic and fishing or sustenance of aquatic life.

Common Sources and Type of Industrial Pollution that are Potential Threats to Water Quality in Kenya

Source	Pollutant(s)
Sugar factory	BOD, COD, pH
Brewery	BOD, COD, N, P, ss
Coffee pulping	BOD, COD, ss, Cu
Metallurgical	Acid, heavy metals, cyanides
Textile	Heat, BOD, COD, chromium, phenol, ss, oil and grease, sulphide
Leather tanning	pH, BOD, Chromium, Sulphides, ss, oils and grease.
Paper mills	BOD, COD, pH,
Slaughter house	BOD, SS
Sewage	BOD, N, P, SS, bacteria and helminthes

In addition, industries such as detergent manufacture, paints, electro-plating, food canning, fish processing, fertilizer and pesticide manufacturing, sulphuric acid plants, fluoride mining, contribute to various types of pollutants including heat, nutrients, heavy metals, acids, and detergents.

Priority Variables

From the foregoing discussion, the following parameters are proposed for standardisation.

1st Priority

- Electrical conductivity
- pH
- Temperature
- Total dissolved solids
- Suspended solids
- Biochemical Oxygen Demand
- Chemical oxygen demand
- Heavy metals:
  - Lead - Zinc
  - Mercury - Nickel
  - Silver - Copper
  - Arsenic - Chromium
  - Selenium
- Ammonia, sulphide
- Detergents, cyanide
- Oils and grease

2nd Priority

Other pollutants that affect the quality of drinking water and water for irrigation purposes with undesirable consequences on human health and livelihood and which are released into the environment from some of the sources mentioned above include:

Residual chlorine	Kjeldahl nitrogen
manganese	Sulphates
Boron	Calcium
Fluoride	Magnesium
Iron Colour	

4.2.3 Basis of Selection of Variables

Water for drinking and fisheries is accorded top priority. Therefore, the variables to be standardised in order to protect the water resources and enhance environmental health are mentioned below:

Temperature (°C)

Temperature should be less than 25°C for trout farming areas and below 35°C for other regions. As temperature rises, dissolved oxygen decreases. Higher temperatures increase the solubility of many chemical compounds and may influence the effect of pollutants on aquatic life and also affect palatability of drinking water. Heated effluents cause stratification and lowering of dissolved oxygen. Fish have upper and lower limits for optimal growth. Therefore, changes in temperature regimes alter the distribution and species composition of aquatic communities.

Suspended Solids

It is recommended that water should have less than 30 mg/l whether the suspended solid has or has no oxygen demand. Suspended solids blanket spawning grounds, river bed, plant life and benthic organisms. They restrict fish vision and affect gill action. Water transparency is reduced with resultant decrease in primary production.

Biochemical Oxygen Demand (5-day at 20°C)

BOD is not a pollutant itself, but is a measure of organic pollution. Waters with BOD levels less than 4 mg/l are deemed clean while those with BOD more than 10 are considered polluted. High BOD concentrations may limit water use for public consumption, fisheries and irrigation.

Heavy metals

Heavy metal concentration should be less than 0.1 mg/l in combination. They adversely affect fish gills and cause asphyxiation. Heavy metal salts are lethal to fish at very low concentrations especially in soft water. Mercury in particular affects the rate of photosynthesis. At only 1 ppb radioactive carbon can be inhibited by 50%. Organo-mercury fungicides have been shown to halt uptake of carbon at 50ppb. Heavy metals are essential to organisms in trace amounts. At high levels they accumulate in sediments and in aquatic organisms, and are further concentrated in the food chain (biomagnification), hence, they may reach lethal levels.

Lead (Pb)

Less than 0.1 mg/l: Lead is a toxic material that accumulates in the skeletal structure of man and animals. Pb in blood lowers mental performance, causing damage to children.

Mercury (Hg)

Less than 0.005 mg/l: Mercury from industrial effluents is transformed into methyl mercury which accumulates in fish and presents serious hazard to aquatic life and to humans whose diet is rich in fish.

Silver (Ag)

Less than 0.05 mg/l: Silver, like mercury, accumulates in body tissues and is also toxic to aquatic life.

Chromium (Cr)

Total Chromium should be less than 0.5 mg/l while hexavalent Chromium should be less than 0.05 mg/l. The hexavalent form is more toxic than the trivalent form.

Chromium is lethal to fish at very low concentrations.

Zinc (Zn)

Less than 0.5 mg/l: Zinc is relatively non-toxic to man but is acutely and chronically toxic to aquatic organisms, particularly fish. It is widely used in industry and affects the aesthetic quality of drinking water.

Nickel (Ni)

Less than 0.3 mg/l: Any appreciable amount of nickel ions will hinder self purification of a river and it is toxic to some plants at concentrations as low as 0.5 mg/l.

Copper (Cu)

Less than 1.0 mg/l. High concentrations of copper restrict water use for drinking due to taste problems. Very large doses may result in liver damage and at concentrations above 1.0 mg/l it may be toxic to aquatic organisms.

Arsenic (As)

Less than 0.5 mg/l: Arsenic may be acutely or chronically toxic to man.

Cyanides (CN)

Less than 0.1 mg/l: Cyanide renders tissues incapable of oxygen exchange. Levels more than 0.2 mg/l are known to be lethal to fish.

Sulphide - Hydrogen sulphide (S)

Less than 0.1 mg/l: Hydrogen sulphide is lethal to fish at slightly higher concentrations than those of cyanides.

Free Ammonia (NH_3)

Less than 0.2 mg/l: The lethal concentration for a variety of fish species is in the range 0.2 to 2.0 mg/l NH_3.

Phenolic compounds (Phenol)

Less than 0.001 mg/l: Phenolic substances are toxic to fish and other aquatic organisms and taint flesh of fish at sub-lethal concentrations.

Phenolic substances, if released into water for public supply, will be detected through the characteristic taste of chlorinated phenols even with concentration as low as 0.002 mg/l.

Nitrates (N)

Less than 10 mg/l: Nitrates cause eutrophication of fresh waters and methaemoglobinaemia ("blue baby syndrome") in infants.

Phosphates (P)

Phosphates enrich fresh water environment with plant nutrients resulting in rapid algal growth which affect municipal, industrial and recreational uses.

Floating materials

Foam, oils and greases should be absent as they reduce light transmission thus, reducing photosynthesis rate and consequently reducing the rate of re-aeration and dissolved oxygen content of the receiving water body. Floating materials are an aesthetic nuisance.

4.3 SOIL

Soil quality can vary considerably even over a small geographical area. For this reason, international and regional consensus on the kind of soil standards which require drafting as environmental standards is still taking shape.

The general approach adopted by ISO and other National Standards bodies on development of environmental standards has been to start with the standardisation of the methods of analysing soil quality. The British Standards

Institute has at present grouped environmental standards into three categories, namely:

(a) Terminology

(b) Sampling

(c) Chemical and biological methods.

For purposes of regional and international harmonisation, it is recommended that Kenya should retain these broad categories. Further to this, the International Organization for Standardisation has identified subjects on soil quality on which it has already developed or is developing international standards. The standards already developed and published have been adopted by those countries that are developing environmental standards are reference points. For reasons of regional and international harmonisation of these standards and because of the globalisation of environmental issues which has become intense in recent years, especially through such bodies as the World Bank, International Monetary Fund and the United Nations through UNEP, Kenya should use them together with any existing methods as references in developing its environmental standards.

Since KARI already has a publication of methods of soil analysis which are widely used by other soil testing laboratories in Kenya, priority will be given to standardising these methods for which there has also been reasonable regional and international agreement on technical content.

Among the published ISO standards on environment are also a small number which employ well understood principles and technology that can be accessed easily by soil laboratories in Kenya. These include the following standards:

(a) ISO 10381-6 Soil Quality - Sampling:

This has been selected because of its importance as a reference for the other standards proposed.

(b) ISO 11048 Soil Quality - Determination of water soluble and acid- soluble sulphate:

This standard has been prioritised because it is of major role in water pollution resulting from industrial activities in the country.

(c) ISO 11263 Soil Quality - Determination of phosphorus - Spectrometric determination of phosphorus soluble in hydrogen carbonate:

This standard has been prioritised due to the importance of the parameter in testing for application of fertilizers.

(i) ISO 11268-Part 1, Soil Quality - Effects of pollutants on earthworms.

(ii) ISO 11269 - Parts 1 and 2, Soil Quality - Determination of the effects of pollutants on soil flora.

These two standards above are regarded as very important for the generation of data which will be used in the drafting and revision of soil quality standards in future.

(d) ISO 11276 Soil Quality - Determination of pore water pressure - Tensiometer method.

This standard is prioritized because it is a reference for the other standards proposed.

(e) ISO 11266 Soil Quality - Guidance on laboratory testing for biodegradation of organic chemicals in soil under aerobic conditions.

This standard, like ISO 11268 and 11269, is essential for generating of data that will be used for drafting and revision of soil standards in future.

The foregoing ISO standards have also been proposed as references for Kenya standards on those subjects. The methods of analysis are still under discussion and have not yet been standardised at regional and international level. It would therefore be unwise for Kenya to start developing standards based on the draft methods before sufficient agreement has been achieved.

5.0 DEVELOPMENT OF ENVIRONMENTAL STANDARDS AND GUIDELINES

5.1 General

The process of evolving standards should include the components mentioned below in order to be in conformity with existing international procedure.

(1) Enacting

Policy and regulatory framework and development or revision of laws has been done in Kenya and the air, water and soil pollution sectors were found to be the sectors with critical environmental issues that require qualitative and quantitative standards. The water sector is, however, more advanced than others in that guidelines have already been suggested and what remains is their review and standardisation.

(2) Regulation

Establishment of requirements, standards and economic instruments that will ensure compliance and facilitate enforcement in cases of non-compliance.

(3) Permitting

To ensure that polluters understand their obligations specific environmental conditions which are facility-specific would require licensing and permitting system that ensures that polluters are able to monitor themselves.

(4) Inspect and Monitor

In order to ensure that laws on each sector laws are enforced, it is important to inspect collate and analyse environmental quality data, monitor and check compliance or difficulties in achieving compliance in terms of either cost effectiveness or availability of technology. This would facilitate decision-making.

(5) Response

Decisions made from collected data must initiate action from the regulators and the regulated community. This may involve corrective enforcement or legal, legal action, penalties, and choosing of better technology in production or better physical planning.

(6) Evaluation and Planning

When data has been collected and policies implemented, the benefits to the environment must be evaluated and counter-actions planned. Follow-up and feed-back to policy makers is essential so that standards can be revised to take changes into consideration. Therefore, standards developed must be constantly reviewed.

The steps outlined above are undoubtedly dynamic processes as a result of changes in natural resources use, ecology, physical development, social and economic needs.

5.2 Air

5.2.1 Application of Ambient Air Quality Standards

Ambient air quality is defined in terms of air quality parameters which is a useful basis for legislation. Maintenance of desirable air quality is to ensure that the air quality standard has not been exceeded. When exceeded it can be made possible to prove that one or more specific cases are responsible. If exceeded, measures can be taken against those sources that are suspected of causing the

worst pollution and require them to reduce pollution by the best practicable means available.

5.2.2 Approach Adopted

The draft framework legislation requires that standards be formulated in various sectors of the environment. With regard to air quality standards it gives the following:

- Stationary sources.
- Mobile sources.
- Working environment.
- manufacturing.
- Criteria and guidelines for air pollution control technology for both stationary and mobile sources.
- Guidelines for emission of greenhouse gases to control climate change.
- Concentration and nature of pollutants emitted.
- Analytical methods to monitor compliance.
- Establishment of laboratories.
- Emission reporting.

5.2.3 Methodology used in Developing Air Quality Standards

The following logical framework was used in developing the AQS

(1) a checklist of the type of enterprises and development activities that will be regulated was made and the type of emissions expected from them. It was found prudent to start from the common parameters which based on health effect their emission limits for specific parameters are known and the methods of measurement have tested standards. The obvious sources are internationally re-known institutions that have developed standards and guidelines which are in force elsewhere. Since international standards are more comprehensive and taking into consideration Kenya's present capability to enforce them most relevant and urgent to Kenya were selected.

(2) Development of a check-list of the main environmental issues and the detailed parameters that need to be addressed, within the context of Kenya's air pollution problems.

(3) Checking whether the selected parameters are well researched in as far as cause and effect relations has been established.

(4) a subjective consideration of whether the standards are enforceable in practice to serve their purpose.

It was also prudent to ensure that the prescriptions are kept to the minimum. It is assumed that after the standards, the enforcement may be elaborated in everyday permit or operating licences. In selecting the standards/guidelines the following were considered:

(i) Visual observations.

(ii) Aesthetics and possibility of having odorous effects.

(iii) Instrument monitoring.

(iv) Possibility of application of clean technology practices that reduce emission at source such as self monitoring, environmental audits, and certification by laboratories.

Literature was searched concerning practices in other countries and the setting of standards as well as the selection of the parameters for which standards were appropriate. It is apparent that countries have set standards for those parameters that are problematic in their own environment, but a common criterion is apparent in the selection of air quality parameters and monitoring but it is a basis for decision-making for the regulatory agency methods.

5.2.4 Compliance and Enforcement

In order to be meaningful and effective, the standards developed should be easy to comply with and enforceable since establishment of an effective defence of the environment and of human health and welfare against air pollution is a complex process in which a number of tasks must be accomplished to achieve the goal of nationwide compliance. The government as the regulatory agent will have to carry out certain tasks to support the standards. These include:

- the determination of acceptable exposure levels for the population;
- the determination of pollutant concentration in the air and of the adverse effects of the pollutants;

- evaluation of the concentrations that can be achieved in practice and the methods of achieving them; and,
- the choice of methodology for monitoring and surveillance of air pollution.

5.2.5 Comparison of International Practice Standards

Considering that this is the first time AQS are being developed for Kenya, it was important to learn from the experience of other countries.

The countries examined in the present review are Canada, Japan, Sweden, the United States, and the European Community (EC). In addition, the approaches of several EC Member States to the problem of atmospheric pollution control are also examined. We would have very much liked to use the examples of countries with similar circumstances to Kenya especially in Africa. There were none.

The general requirements and procedures for preventing or reducing emissions to air from industrial plants and processes are set out in the European Communities Framework Directive(84/360/EEC). It is the responsibility of each member state to use national standard methods of sampling and measurement to ensure compliance with the emission limits of the"daughter directive". For major industrial processes these have been or are being promulgated for different sectors of industry. For example, in France the Ministry of Environment has cited a number of processes for which there are limits to emissions to the air with specified procedures for their measurement and analysis while in Germany the sampling of gaseous and aqueous media is covered by DIN Standard which is almost the same case in Japan and the USA. A few examples from developing countries are mentioned below.

(a) Developing Countries

(i) Philippines

Monitoring and compliance of vehicle emissions with ADS is done by the Land Transport Office, Local Government Units, Philippine National Police, Department of Environment and National Resources. For stationary sources monitoring compliance is done by DEAR (Regional Office) through permitting functions. It includes regulation of potential (emission) sources such as full quality. It is important to note that the Philippine's enforcement scheme does appear to link the control of emissions to a health based ambient standard. For industry the permit system ensures continuous emission monitoring of air with record keeping and reporting of the same; however, there is no regular follow-up to ensure compliance.

(ii) South Africa

Before independence in 1994, air pollution was under the Department of Health where scheduled processes were governed by individual permits and permit holders were required to report regularly to the Chief Air Pollution Control Officer; however, there were only six (6) air pollution control officers for the whole country.

Local air pollution issues such as urban smokeless zones programmes were dealt with in the past at the municipal level. Currently, there is the Atmospheric Pollution Prevention Act (No. 45 of 1965) under which permits have been issued for scheduled processes on a case by case basis. Permit holders have been required to report regularly especially on particulate emissions; however, the Chief Air Pollution Control Officer's ability to enforce those provisions have been limited. Monitoring of gaseous emissions is rare in South Africa, but it is generally agreed that neither the government nor the private sector can accurately state the pollutants being emitted. A network of monitoring stations evaluating ambient air quality does exist.

(iii) Nepal

Use of pollution inventory-emission factors taken from publications of the US-EA and WHO are extensively used. There is no actual physical monitoring however, inventories have force of law.

(iv) Hong Kong

The Environmental Protection Department (ED) operates a network of eight monitoring stations to provide comprehensive measurements of air quality throughout the year. At each station gaseous pollutants are measured continuously and particulate matter is sampled according to its size every 6 days. Air quality statistics is made on the basis of protecting public health most important pollutants are particulate matter and nitrogen dioxide.

(b) Developed Countries

Developed countries have air quality standards which have been effective in reducing air pollution. It could have been easy to prescribe air quality standards from developed countries. It was found useful to indicate current practices in developing countries with circumstances similar to Kenya's before standards could be proposed. Many countries have set AQS based on averaging time.

The following are the averaging times commonly uses. All measurements are at 298K (25°C)

(a) hourly averages not to be exceeded three times a year;

(b) 8-Hour averages not to be exceeded more than once per year; and,

(c) three months arithmetic means.

The averaging times selected are based on the method of measurement.

If it is intermittent, then the hourly average looses meaning and the 24 hour average may apply. The specific standards for various air pollutants are given in the tables below.

Table 5.1: Particulates (Averaging time and Concentration in Micrograms per M^3)

Country	1hr	8hr	24hrs	3mths	1 year
Hongkong	-	-	260	-	80
Japan	0.2	-	0.1	-	-
Italy	-	-	300	-	-
United States	-	-	150	-	-
Canada	-	-	-	-	120
WHO	-	-	-	-	60
Proposed for Kenya	-	-	260	-	80

Table 5.2: Sulphur dioxides (Averaging Time and Concentration in Micrograms per M^3)

Country	1hr	8hr	24hrs	3mths	1year
Hongkong	800-	-	350	-	80
Japan	0.1	-	0.04	-	-
Italy	-	-	390	-	-
United States	-	-	365	-	-
Canada	900	-	300	-	900
WHO	-	-	-	-	60
Proposed for Kenya	-	-	400	-	400

Table 5.3: Carbon Monoxide (Averaging Time and Concentration in Micrograms per M^3)

Country	1hr	8hr	24hrs	3mths	1year
Hongkong	3000	-	1000	-	
Japan	200	-	100	-	-
Italy	-	10,000	-	-	
United States	40,000	-	10,000	-	-
Canada	35,000	15,000	-	-	-
WHO	-	10,000	-	-	-
Proposed for Kenya	-	-	10,000	-	-

Table 5.4: Nitrogen Dioxide (Averaging Time and Concentration in Micrograms per M^3)

Country	1hr	8hr	24hrs	3mths	1year
Hongkong	300	-	150	-	80
Japan	40	-	60	-	-
Italy	-	-	200	-	-
United States	-	-	-	-	100
Canada	-	-	200	-	-
WHO	-	-	-	-	90
Proposed for Kenya	-	-	200	-	100

Table 5.5: Photochemical Oxidants (Averaging Time and Concentration in Micrograms per M^3)

Country	1hr	8hr	24hrs	3mths	1year
Hongkong	240	-	260	-	80
Japan	0.06	-	0.1	-	-
Italy	-	-	200	-	-
United States					
Canada	160	-	50	-	30
WHO	-	-	-	-	-
Proposed for Kenya	-	-	260	-	80

Table 5.6: Lead (Averaging Time and Concentration in Micrograms per M^3)

Country	1hr	8hr	24hrs	3mths	1year
Hongkong	-	-	260	-	80
Japan	0.2	-	0.1	1.5	-
Italy	-	-	-	-	2.0
United States	-	1.5	-	-	-
Canada	-	-	-	-	-
WHO	-	-	-	-	1
Proposed for Kenya	-	-	1.5	-	2.0

Sources: (1) *Environmental International Vol.10. pp 507-521,1984*

(2) Comparative Analysis of US Environmental Control Technologies for refractory Gold Treatment Process: Industry and Environment Vol 18 No 2-3,1995.

(3) Urban Pollution:UNEP/GEMS Environment Library No.4.

5.2.6 Priority Air Pollutants for Kenya

Air quality standards found necessary in order of priority include workplace and residential facilities, ambient atmospheres, selected stationary sources, and transport/ mobile sources. In developing this priority list ,the following remarks are made:

(i) Workplace and Residential Facilities

The Factories Act is implementing AQS suggested by ILO and hence it was realised that it would amount to duplication of work if this was repeated. However, the expression "other places of work", places a limitation on the scope of addressing emission sources which do not fall within the definition of the Factories Act such as residential houses, sewerage treatment works and agricultural activities.

(ii) Air Quality Limits in the Atmosphere

Because of the hitherto sectoral approach to AQS determinations for ambient air quality, there has been a confusion of the terms, units, codes of measurement, and monitoring criteria. The proposed AQS Limits will harmonise this.

These parameters are:

(a) Dust, particulate Matter and Aerosols

(b) Carbon monoxide

(c) Sulphur dioxide

(d) Carbon monoxide

(e) Lead

5.2.7 Standards Developed

The standards developed fall under the following broad areas:

(a) ambient air quality limits;

(b) general aspects, which are intended to harmonise language , units and references;

(c) emissions from stationary sources;

(d) mobile sources; and,

(f) guidelines for minimisation of emissions.

Limits

Limits on emissions to the atmosphere will be cited as concentrations averaged over time. In order to avoid the use of dilution to meet such limits, standards reference conditions must be specified.

Emitted concentrations of pollutants are usually specified at standard temperature and pressure (STP), that is 273 degrees centigrade and 101325 kPa (about 1 atmosphere). Correction for water vapour is sometimes required so that results can be presented in terms of dry gas. The following shall apply for the ambient air (emission limits).

No.	Pollutant	Guideline	Limit Level	Standard
1.	Black smoke and suspended particulate matters(SPM)	Black smoke 40-60µg/Nm^3 (0.05-0.08 mg/kg Total SPM 60-90 µg/Nm^3 (0.05-0.116mg/kg)	Daily average of hourly values shall not exceed 90.10µg/Nm^3 and hourly values shall not exceed 0.20µg/Nm^3	DKS/ISO 3 DKS1163/3
2.	Carbon Monoxide, CO	Aims at preventing carboxyhaemoglobin levels exceeding 2.5-3% in non-smoking	1. A maximum permitted exposure of 100 mg /Nm^3 for periods not exceeding 15 minutes. 2. Time-weighted exposures at the following levels: 60mg/Nm^3 for 30 minutes: 30mg/Nm^3 for 60 minutes: 10 mg/Nm^3 for 8 hours or Daily average hourly values shall not exceed 10mg/kg and average hourly values in eight consecutive hours shall not exceed 20mg/kg	KS/ISO8186
3.	Sulphur Dioxide,SO_2	Annual mean 40-60 µg/Nm^3(0.05-0.08 mg/kg) or 24-hour average 100 µg/ Nm^3(0.129 mg/kg)	Daily average of hourly values shall not exceed 0.04 mg/kg and hourly values shall not exceed 0.1 mg/kg	DKS/ISO6767
4.	Nitrogen dioxide, NO2	Levels of 400 µg/Nm^3 (0.5 mg/kg) for 1-hour	150µg/Nm3 for 24 hours average value	

Emission Sources

The following Limits shall Apply for Emission Sources

No.	Pollutant	Guideline	Limit Level	Test Method
1.	Sulphur Dioxide,SO_2	Liquid fuel combustion with heat output from 5MW to 300 MW or solid fuel combustion with heat output from 50MW to 300MW	Not to exceed 1700mg/m3 in the carrier gas (24th mean value)	
2.	Carbon Monoxide, CO	Liquid fuel combustion with heat output exceeding 5MW. Solid fuel combustion with the heat output of 50 MW and above	Not to exceed 175mg/Nm^3 Not to exceed the level of 250 mg/Nm^3	
3.	Hydrocarbon		Not to exceed 20 mg/Nm3	
4.	Dust	Inert dust including, cement	Not to exceed 250mg/Nm3 (24thm mean value)	

5.2.8 General Aspects

(1) DKS/ISO 9745: Vocabulary

(2) DKS/ISO 4226: Units of measurement

(3) DKS1163930

Part 1: Guidelines for Planning the Sampling of atmosphere and Location of monitoring stations.

Part 2: Sampling of gaseous pollutants.

(4) DKS/ISO8756: Handling of temperature, pressure and humidity data.

5.2.9 Standards Methods of Testing Ambient Atmospheres Pollutants

(5)DKS/ISO 7708: Particle size fraction definitions to health related sampling

(6)DKS/ISO 1163(3) Dusts and Particulate Matter: Determination of a black smoke index.

(7)DKS/ISO8186: Determination of the mass concentration of carbon monoxide - Gas concentration of carbon monoxide - Gas chromatographic method.

5.2.10 Standard Methods of Measuring Stationary Source Emissions

(8) DKS/ISO(1163)/4: Determination of gaseous sulphur compounds in ambient air- sampling equipment.

9) DKS/ISO6767: Determination of the Mass Concentration of Sulphur dioxide - tetrachloromercurate(TCM) pararosaniline method.

5.2.11 Standard Methods of Measuring Pollutants from Mobile Sources

(10) DKS/ISO7644: Measurement of capacity of exhaust gas from compression-ignition(diesel) engines-Lug -down test.

(11) DKS/ISO3929: Apparatus for measurement of exhaust gas from diesel engines operating under steady state conditions.

5.2.12 Monitoring

Monitoring emissions will be through systematic air quality measurement programme that will use measurement methods and inventories. With measurement, the initial stages will involve use of hand held portable analyses for collecting data on air quality. Over the years the sophistication and accuracy of these equipment has reached a level parallel to the standard methods of analysis.

The purposes for monitoring in the context of these standards are varied and may include any of the objectives stated below.

(i) Estimate the amount and composition of air pollution for an area.

(ii) Establish a database for trends in the degree of pollution with time, year to year or day to day.

(iii) Determine the source and dispersion of air pollution on the local, regional and global scale.

(iv) Determine the impact of air pollution on human health, animals, vegetation and materials.

(v) Ensure compliance with the above standards.

(vi) Assess impact of policy measure and their effectiveness.

(vii) Give short-term warning of pollution risks.

The methods used will vary from time to time. It is expected that the detailed methods of analysis of the parameters standardised here are many and they will not be reproduced here. It suffices to mention that the WHO has detailed these methods for general atmosphere. The UNEP Industries and Environment Unit has one for industrial emissions (see references).

Methods developed for work-place atmospheres are sometimes suitable for or can be adapted for the measurements of particulate and/or gases in process streams.

5.2.13 Sampling

Sampling in gaseous streams involves extractive techniques for both particulate and gases. Sampling for particulate is usually more difficult than for gases, as more account must be taken of the conditions of the gaseous environment and the characteristics of the particle. It is important to have definitions of the particle to be controlled and the method

of analysis. Three gas samplers are suggested. They are BDX by Sensidyne of USA for lead and asbestos; Mini-GASS from Perma-Pure; and, Sieger Aspirated Gas Sampling System from Zellwegger Analytic (UK).

5.2.14 Data Analysis and Reporting

Data will be collected at site and in laboratories. Its analysis is crucial to decision making. Multi-parameters analysers are gaining ground, and, the following are suggested:

(i) Horiba Ltd 250.

(ii) Model 350 Ultraviolet photodiode analyses from Land Combustion(UK).

(iii) Drager Sensors.

(iv) Suspended particulate analytical method.

For discrete sampling, instantaneous values can be converted to means, maxima and minima or standard deviation over chosen intervals. For continuous logging and processing, the data can be reduced to 3-min, hourly or other relevant intervals as means, maxima and minima, standard deviation or variances.

For continuous or composite sampling, time and flow-averaged values over the period of sampling can be determined. The values may be expressed in terms of concentration or mass.

5.2.15 Inventories for Point Sources

It is common in large manufacturing enterprises to carry out inventories. The inventories give an idea of total emissions. Essential features and problems to note are the following:

(i) the low range of concentrations measured is related to an occupational exposure limit and is therefore low;

(ii) The moisture content in work-place atmospheres is usually low, but it can be very high in process streams;

(iii) process streams operate at a range of temperatures and pressures that may require special sampling systems; and,

(iv) in using gas detector tubes for measuring gas concentrations in a process stream, account should be taken of other interfering gases.

5.2.16 Guidelines for Emission Control

It is most likely that not all emissions can be regulated. It is therefore, important to give an indication that potential polluters are making effort to minimise emissions. The guidelines stated below are suggested to meet the objectives indicated for each guideline.

(1) Guideline for Minimisation of Fugitive Gaseous Emissions

The objective is to minimise fugitive gases from selected sources in the sector of volatile organic compounds. Solvent standards are difficult to monitor since there are many diffuse sources and effective concentrations are low considering the capacity of Kenya to monitor them. The guideline shown below is only for indication purposes and is by no means exhaustive.

Industry	**Suggested Emission Reduction Measures**
Chemical Industry	- Floating roofs for storage tanks. - Improved management, maintenance and control of valves, pumps and tanks to prevent diffuse emission.
Painting Industry	- Application of low -VOC or VOC-free paints and lacquers. - Reduction of emissions from over-spray with improved technologies.
Metal Industry	- Reduce emissions of solvents by substituting with paints low in or free of solvents. - Substitute detergents and degreasing agents with non-organic substances(soap,water, among others).
Printing Industry	- Reduction of solvent emissions through application of recycling or absorption systems. - Application of biofilters to reduce solvent emissions. - Substitution with low solvent or solvent free inks.

(2) Minimising Emissions from Stationary Sources

The objective is to help potential polluters appreciate the air quality impacts of their activities for the stationary sources that can be controlled by reducing emissions at source such as industries and energy generation systems.

(a) The first point of control will be at the environmental impact assessment stage where a proponent will understand the processes that bring about air pollutants.

(b) Appreciation of the local environmental condition and the local authority's desired ambient air quality.

(c) Approvals of emission guidelines will take into consideration the application of the best available technology that is economically feasible.

(3) Procedure for Emissions Inventory

The objective is to assess potential emissions by Stoichiometric methods. The basis for the use and application of the guidelines will be on assessment of the:

(a) substances which are likely to be emitted from all sources including possible diffuse sources.

(b) mass flow volume for the various substances and groups of substances; and,

(c) volumes of each substance emitted to air;

(4) Chimneys and Fume Stacks

The objective is to ensure maximum dispersal and reduce exposure. The following guidelines will apply in the construction of chimneys.

(a) All chimneys and stacks for ventilation units should always be placed so that it is not possible for polluted air from the stack or chimney to enter through windows, doors, air intakes to ventilation unit or adjacent buildings of the premises or those of neighbours.

(b) Large-scale units such as energy generation, petrochemical refining, among others, should endeavour to use appropriate meterological and computer model to calculate the dimensions of the fume stacks including the height.

5.3 Water

5.3.1 Proposed Standards

The process of evolving standards should include the components stated below in order to be in conformity with existing international procedure.

(a) Specification or tolerance levels for the selected variables for discharge:

(i) into inland waters;

(ii) into public sewers;

(iii) onto land for irrigation purposes; and,

(iv) into marine coastal areas.

(b) Standard vocabulary or terminology.

(c) Standard methods for sampling and preservation.

(d) Standard methods of test.

Specifications for Effluent Discharge

As explained in the Chapter 4, in order to protect water resources for domestic use and sustenance of aquatic life, specification for selected variables are proposed for a start for two areas, namely, discharge into public sewers, and discharge into inland waters.

Standard Vocabulary

The proposed standard vocabulary is adopted from ISO 6107 series for water quality (Annex 2)

Standard Methods of Sampling

The methods for sampling and preservation to test for compliance are adopted from ISO 5667 series on water quality sampling (Annex 2).

Table 5.7 Proposed Effluent Discharge Standards (a) into public sewers (b) into inland waters

Parameter	Proposed Effluent Discharge Standards	
	(a) Into Public Sewers	(b) Into Inland Waters
Suspended solids mg/l	500	30
Total dissolved solids mg/l	2000	1200
Temperature °C	35	30
pH value	6.0 - 9.0	6.0 - 9.0
Oil and grease mg/l	10	Nil
Ammonia Nitrogen mg/l	20	-
Ammonia Free mg NH_3/l	10	0.2
BOD (5 days at 20°C) mgO_2/l	500	20
COD mgO_2/l	1000	50
Arsenic mg/l	0.2	0.02
Mercury mg/l	0.05	0.005
Lead mg/l	1.0	0.1
Cadmium mg/l	0.5	0.1
Chromium (VI) mg/l	0.05	
Chromium total mg/l	2.0	2.0
Copper mg/l	1.0	0.05
Zinc mg/l	5	0.5
Selenium mg/l	0.2	0.05
Nickel mg/l	3	0.3
Silver	2	
Nitrates	20	10
Phosphates	30	-
Cyanide mg/l	2	0.1
Sulphide mg/l	2	0.1
Phenols mg/l	10	0.001
Detergents	15	
Total Coliforms per 100ml	-	1000

Standard Methods of Testing

Current Practise

Currently, the Central Water Testing Laboratory of Ministry of Water Resources(MWR) and the Government Chemist Department use test methods described in the "Standard Methods for Water and Waste-water Examination" by the American Public Health Association and The American Water Works Association. Methods described in the "GEMS/ Water Operational Guide" are also used especially for inter-laboratory comparison studies coordinated by the Global Reference Laboratory in Cincinnati, United States of America.

The three East African countries of Tanzania, Kenya, and Uganda are all familiar with the methods of analysis described in the latter. Furthermore, the regional Lake Victoria Environmental Management Programme has already adopted common methods for measuring water quality as described in the GEMS/Water Operational Guide. The Programme has recommended the "Standard Methods" as a cross reference.

Recommendation

It is proposed that these methods be adopted as standard methods for testing compliance with the water quality standards. Additional test methods may be adopted from the ISO standards as necessary. The methods specified in the "Specification for Drinking Water KS 05-459 of 1985" should also be used where applicable.

A summary of the proposed test method for each variable is given in **Table 5.9**

Table 5.8 Proposed Standard Test Methods

Parameter	Method	Reference
pH	Electrometric	KS-05-459 Part 2
Electrical Conductivity	Conductivity Meter	KS-05-459 Part 2
Dissolved Solids		KS-05-459 Part 2
Suspended Solids	Gravimetric	KS-05-459 Part 2
BOD(5 days at 20_C)	Winkler	APHA, 1992
COD (dichromate)	Closed reflux	APHA, 1992
Chromium	-Spectrometric using	
	1,5-diphenylcarbazide	DKS/ISO 11083
	-Atomic Absorption	
	Spectrophotometry (AAS)	APHA, 1992
Cadmium	Flame AAS	APHA, 1992
Lead, Mercury	"	"
Zinc, Nickel	"	"
Cobalt, Copper	"	"
Arsenic	-Silver diethyldithio-	
	carbamate Spectrometric	APHA, 1992
Selenium	-AAS	DKS/ISO 9964-3
Ammonia	Nesslerisation	APHA, 1992
Nitrates	-Cadmium reduction	
	Spectrophotometry	APHA, 1992
Phosphates	-Ascorbic Acid	APHA, 1992
Detergents	-Methylene blue	
	Spectrometric	DKS/ISO 7875-1
	-Dragendorff reagent	DKS/ISO 7875-2
Oils and Grease	-Gas chromatography	-
	-Organic solvent	
	extraction	KS-05-459 Part 6
Cyanide	Ion-selective	
	Electrode	KS-05-459 Part 5
		DKS/ISO 6703
Sulphide	-Iodometric	KS-05-459 Part 5
	-Photometric/	
	Methylene blue	DKS/ISO 10530
Phenols	-Gas Chromatographic	DKS/ISO 8165-1
	-Amino antipyrine/	
	Spectrophotometric	KS-05-459 Part 6
Total coliforms	Multiple tube	KS-05-459 Part 3
	Membrane filtration	KS-05-459 Part 3

5.3.2 Recommendation for Effective Implementation and Enforcement of Standards

Effective implementation of the proposed standards involves monitoring compliance, research and review as appropriate. The role of these and persons or institutions, namely, the state, the public, and polluters involved, should be specified in national laws.

Monitoring Compliance

The essence of monitoring is systematic surveillance in accordance with specified procedures to provide information that can lead to better decision-making about environmental quality in general and industrial operations' adherence to set standards in particular. Monitoring can be undertaken by the government, the public, and the industries themselves.

Role of the State

The lead agency (government or semi-government) should institute a comprehensive and well managed monitoring programme. As discussed in section 2.2.3, there is an effluents sampling programme and an ambient water quality monitoring programme within the Ministry of Water Resources. However, to overcome some of the operational problems cited earlier, the Government should boost budgetary allocations to the programmes. Funding could be obtained through levies on water abstractions and penalties for water pollution. In the latter case, pollution charges should be based on the volume of industrial effluents and the subsequent treatment and disposal costs. In addition, industry should contribute to the installation and maintenance of facilities such as automatic sampling stations.

- Effluent sampling and water quality monitoring programmes review: there is need to undertake reconnaissance studies to determine the siting of stations, sampling frequency, and parameters to be analysed. Furthermore, to aid measurement of flow, the Regular Gauging Stations (RGS) network should be reviewed. Closed RGSs should be rehabilitated and others set up at points where major industrial effluents are discharged to water bodies.

- Strengthening of the analytical capabilities: the provision of analytical services is crucial to the successful implementation of the monitoring programme. The Ministry of Water Resources has a central water testing laboratory in Nairobi which acts as a referral laboratory. Each province has a small laboratory which can test for a few basic parameters such as pH, conductivity, dissolved oxygen and total coliforms. There is need to strengthen the analytical capabilities of the provincial water laboratories and also district water laboratories, where applicable.

- Inspections as mentioned in Chapter 2, these have been hampered by logistical problems which could be overcome as already suggested.

- Negotiations with industry should continue as they can lead to cooperative efforts in developing satisfactory solutions. Negotiation, however, should not be allowed to change basic requirements for compliance.

- Economic instruments: introducing incentives such as tax waivers or reductions for equipment intended for cleaner production or waste water treatment; disincentives such as pollution levy or "green" tax on polluters. In addition, the government should facilitate access to financial resources for cleaner production and/or waste water treatment.

- Provide penalties for persistent polluters should be deterrent. The Water Act is currently being reviewed to cater for stiffer penalties. The draft Environment Management and Coordination Bill has also made some proposals to this effect.

- Permitting: issuance of permits which can be withdrawn in case of persistent non-compliance.

- Education and awareness: the Government should undertake an aggressive education and awareness campaign to promote compliance by disseminating information about environmental standards, cleaner production, technical assistance, building public awareness and support, publicizing success stories, among others.

Role of Industry: Self-monitoring

Individual industries should have an internal environmental management system for monitoring adherence to set national pollution standards, that is, auditing. This requirement should be specified in the law. An environmental management system or auditing requires that each industry has its own environmental policy, objectives, targets and implementation plan. The industry should in addition take the responsibility for training, awareness, communication network, environmental documentation, emergency preparedness and corrective measures.

Role of the Public

Communities should be encouraged to act as the watch-dog. A forum for citizen complaints should be provided.

Review of Standards (Baseline Studies)

The importance and need for baseline data collection cannot be over-emphasised. A database should be set up. The monitoring programme should embark on baseline data collection. The use of biological methods for water quality assessment using indicator organisms including bio-assay organisms, accumulators, exploiters, detectors, and sentinels, should be instituted.

The baseline studies should be undertaken prior to the establishment of industry but should continue as part of the monitoring programme. Collaboration with other relevant institutions should be undertaken as such studies require an integrated multi-disciplinary/multi-sectoral approach.

Research and Development

Research institutions are important in providing answers to ecological and technological problems.

The Government and industry should support research activities to facilitate the acquisition of data and information necessary for the review of environmental standards; and the development of technology that is appropriate for waste minimisation and/or effective waste treatment should be undertaken.

Information Exchange/Networking

Information required for the implementation of environmental standards includes stake-holder needs, baseline data, and information on water quality, public health recommendations, technological, and economic capacity to implement standards, among other things.

A multi-agency information system or network (UNEP, 1996) where all players are equal but with one acting as "the hub" or coordinator is recommended. The National Environment Secretariat can fulfil this role. An Environmental Standards Steering Committee would manage the network with various technical teams on air, water and soils implementing the system while all stakeholder participate.

The role of the Steering Committee would be to ensure that feed-back is obtained from the technical teams (custodians) in each agency and other stake-holders or users, such as industries, on difficulties or obstacles experienced in the implementation of standards.

The functions of the coordinator or hub include identifying national information priorities, evaluating performance of participating agencies and assessing their capacity building needs (such as training, equipment); fostering inter-agency and international cooperation, redirecting enquiries/ requests to the most appropriate agency and disseminating information, for instance, through public *barazas*, the print and electronic media, workshops, and seminars.

Enforcement Authorities needed

The authorities needed for the enforcement of the effluent discharge standards include the current key actors in the water sector, namely, the Ministries of Water Resources, Health, Local Government and its Local Authorities, Labour, and the Kenya Bureau of Standards. In addition, a central coordinating agency is necessary.

5.3.3 Enforcement of Standards Across Borders

a cross-border enforcement of standards should begin with the inter- laboratory calibration of sampling, preservation and test methods to ensure results obtained are comparable. For biological methods of water quality assessment, a regional protocol for the use of invertebrate communities should be established. A regional network of monitoring stations possibly including the already existing Global Environmental Monitoring Systems (GEMS/water) stations should be established. A regional coordinating committee and a regional panel of experts may facilitate the collection and exchange of data for standards setting and updating. Furthermore, at the regional level there will be need for an environmental tribunal to settle cross-border issues regarding non-compliance with set regulations and standards.

5.4 Soil

5.4.1 Development of Standards

Taking into consideration the issues discussed in the previous chapters the following KS/ISO Draft Standards have been proposed:

- DKS/ISO 466 Soil Quality - Extraction of trace elements soluble in aqua regia.

- DKS/ISO 10381-6 Soil Quality - Sampling

	Part 6: Guidance on the collection, handling and storage of soil for the assessment of aerobic microbial processes in the laboratory.
- DKS/ISO 10390	Soil Quality - Determination of pH.
- DKS/ISO 10693	Soil Quality - Determination of carbonate content - Volumetric method.
- DKS/ISO 10694	Soil Quality - Determination of organic and total carbon after dry combustion (elementary analysis).
- DKS/ISO 11048	Soil Quality - Determination of water-soluble and acid-soluble sulphate.
- DKS/ISO 11260	Soil Quality - Determination of effective cation exchange capacity and base saturation level using barium chloride solution.
- DKS/ISO 11261	Soil Quality - Determination of total nitrogen - Modified Kjeldal methods.
- DKS/ISO 11263	Soil Quality - Determination of phosphorus - Spectrometric determination of phosphorus soluble in hydrogen carbonate solution.
- DKS/ISO 11265	Soil Quality - Determination of the specific electrical conductivity.
-DKS/ISO 11268-1	Soil Quality - Effects of pollutants on earthworms (*Eisenia fetida*).
	Part 1: Determination of acute toxicity using artificial soil substrate.
- DKS/ISO 11276	Soil Quality - Determination of pore water pressure - Tensiometer method.
- DKS/ISO 11269-1	Soil Quality - Determination of the effects of pollutants on Soil Flora.
	Part 1: Method for the measurement of inhibition of root growth.
	Part 2: Effects of chemicals on the emergence and growth of higher plants.
- DKS/ISO 11464	Soil Quality - Pretreatment of samples for physico-chemical analyses.
- DKS/ISO 11465	Soil Quality - Determination of dry matter and water content on a mass basis by a gravimetric method.
- DKS/ISO 13536	Soil Quality - Determination of the potential cation exchange capacity and exchangeable cations using barium chloride solution buffered at pH 8.1.

5.4.2 Implementation and enforcement of soil standards

The Draft Environmental Management and Co-ordination Bill, 1995, as amended and the National Environment Action Plan process have dealt with the issue of implementation and enforcement of environmental standards in great detail. The proposals made are regarded as adequate to address implementation and enforcement of soil standards.

The main objectives to be achieved in the enforcement of standards on soil are to:

- prevent degradation of soils,
- increase productivity of soils on a sustainable basis,
- promote optimal use of soils, and
- enhance overall environmental protection.

In order to realise these objectives, it will be necessary to do an inventory and classification of soils, establish a data bank on soils, identify causes of soil pollution and soil misuse, and to continually monitor soil conditions.

The regulations that will be required to implement and enforce these standards will deal with the following subjects:

(a) provisions for all matters in respect of which fees become payable;

(b) prescription on amounts of fees and the persons who are liable to pay;

(c) prescription of the forms to be used;

(d) provisions for matters connected with appeals;

(e) provisions for requiring persons to supply information relevant to the provisions under the Act or Regulations;

(f) accreditation of soil testing laboratories; and,

(g) appointment of inspectors and analysts.

At the Secretariat to the East African Co-operation Agreement, a department should be established to co-ordinate cross-border implementation and enforcement of standards in East Africa. Among other duties, this department will be charged with the responsibility of collecting information on standards that require harmonisation to minimise conflicts. The department will also be responsible for arranging regular meetings of the directors of the bureaux of standards in East Africa to deliberate on issues of cross-border implementation and enforcement of standards.

CHAPTER 6

6.0 CAPACITY BUILDING

In order to assess the human and technical resource requirements, local consultations were undertaken covering key actors in the public and private sectors, including:

a) Ministry of Water Resources - Water Quality and Pollution Control Division;

b) Government Chemist Department;

c) Ministry of Health - Environmental Health Division;

d) Ministry of Resources - Mines and Geological Department;

e) Nairobi City Council - Water and Sewerage Department;

f) Twiga Chemical Industries;

g) Kenya Agricultural Research Institute - National Agricultural Laboratories;

h) University of Nairobi - Institute of Nuclear Science;

i) Kenya Association of Manufacturers;

j) Kenya Bureau of Standards;

k) Kenya Industrial Research and Development Institute;

l) Tea Manufacturing Industries;

m) Chemical Industries;

n) Sisal Industries;

o) Tanneries;

p) Quarries and Mining sites; and,

q) Ministry of Environmental Conservation.

6.1 Air

6.1.1 Role and Scope of Key Actors

The existing legal machinery generally places an obligation accruing to existing laws of the country, on developers to take specified actions to pollution effects emanating from gaseous emissions. The definition of what constitutes air pollution is left to administrators to decide.

In the past the Central Government, through specialised institutions, has attempted to interpret the law and provide guidance on this matter. The most notable of them have been through the on-and-off Inter-ministerial Committee on Environment Special Committee on Factories which works with the members of the District Development Committees and relevant local authorities. The Committees' work has been hampered by lack of legal guidance on the quantities and types of emissions to be control.

The key institutions that will have an interest and role in implementing the standards are discussed below. Their possible roles are illustrated in italics. A summary of institutional air quality management is shown in **Table 6.1.**

(i) The Inter-ministerial Committee on Environment (IMCE)

The IMCE is the central environmental policy-making institution in Kenya. Its members are also key actors in implementing various standards.

The co-ordination role of the IMCE is to promote the integration of environmental policies and to advise the GOK and other institutions on matters related to the state of environment, and especially in connection with the monitoring, assessing and evaluating the impact of development activities on the environment. The Ministry of Environmental Conservation is the chair, while the National Environment Secretariat serves as its secretary.

It will monitor the implementation of the standards and recommend improvements on their harmonisation.

(ii) The National Environment Secretariat

The National Environment Secretariat (NES), a government department in the Ministry of Environmental Conservation, was established in February, 1974. It performs a co-ordinating and catalytic role in the protection and enhancement of environment for the benefit of all Kenyans. NES is the government link with the international organisations dealing with environmental matters mainly UNEP. It plays a central role in information exchange. It regularly receives information from IRPTC, ICPS, FAO, UNIDO and USEPA.

It will have the central co-ordinating role for the establishment of a national monitoring station and baseline stations.

(iii) National Council for Science and Technology (NCST)

The National Council for Science and Technology (NCST) was established by the Science and Technology Act (Cap 250) of the Laws of Kenya on 1st July, 1977. The NCST is, therefore, a statutory institution of the government reporting to the government through the Ministry for Research Technical Training and Technology. The functions of the Council are inter-ministerial in nature and it is free to interact directly with all government ministries and institutions as well as the general public and the private sector. This facility also extends to interactions with international organisations and institutions subject to normal protocol requirements.

The NCST is the national focal point for science and technology policies and advises the government on all aspects of science and technology especially their applications for national development. To this end, it advises on scientific documentation, statistics, surveys and general information. It is mandated to establish the necessary machinery for the collection and dissemination of scientific and technological information. It has consequently established a department on scientific information.

It will advise on the appropriateness of the concept of the Best Available Technology to minimise gaseous emissions.

(iv) The Directorate of Occupational Health and Hygiene (DOHSS)

This a specialised occupational health department in the Ministry of Labour. From an occupational point of view, the DOHSS monitors the identification and assessment of personal exposures to chemicals in the industrial sector, but only to the level of monitoring the causative agents and not the mechanism of effect.

It administers the Factories Act, Cap 514. It had, by 1992, 60 Occupational Health and Safety Officers distributed through 12 regional offices. These specialists include engineers, physical scientists, doctors, hygienists and nurses. Further recruitment is under-way. It is expected that by the end of 1998 the department would have 200 professionals. It has information on industrial and other chemicals used in the working environment. Often, it also has information on toxicity data, but generally based on the working environment where chemicals are being used.

It is best placed to enforce workplace standards.

(v) The Government Chemist Department

The Government Chemist is the department responsible for all Government chemical tests for the whole country that may have legal relevance. It is able to analyse all types and groups of chemicals, but in time it has focused the bulk of its effort to the following areas:

- chemical analysis of foods;
- water quality analysis;
- forensic sciences; and,
- deliberate and accidental poisonings.

Samples for chemical analysis come from the police, manufacturers, individuals, and many government institutions. The Department works closely with the National Public Health Laboratories. It has laboratories in Nairobi, Mombasa and Kisumu.

It can widen its scope to include laboratory analysis of air samples and calibration of equipment.

(vi) The National Public Health Laboratories (NPHL)

The Ministry of Health (MOH) administers the NPHL where food is analysed to check for contamination. The MOH also runs the Medical Training Centre where Public Health Officers and Food Health Inspectors are trained and deployed to the divisional and the locational levels to act as the Government watch-dog on the quality of food in all stages of harvesting, transportation and processing.

The health inspectors have proved to be the best medium of transferring information on health matters in general, and chemicals in particular, to the grassroots level since they are the first to be called in whenever there is an issue affecting the health of the people. They take their samples for chemical analysis to the NPHL nearest to them since these facilities are in nearly all provincial hospitals.

The NPHL have capability to analyse food for microbiological and fungal contaminants, pesticide and heavy metal residues.

It is best placed to monitor small scale enterprises.

(vii) The Nairobi City Council (NCC)

The Nairobi City Council has developed its own laboratory and inspectorate facilities since it has a larger concentration of enterprises where water and food contamination may occur. NCC collects and analyses food samples as well as water samples. All restaurants and eating-houses are inspected either for licensing or routine monitoring. The information storage includes hospital records for reported cases of poisoning.

It is best placed to regulate emissions from small-scale enterprises and also the control of emissions from the densely populated or industrialised areas.

(viii) The Kenya Bureau of Standards (KEBS)

This is a *quasi* government institution that runs mostly on commercial basis. It specialises in information on industrial chemicals, food additives, utility chemicals, and safety levels in compliance with relevant product standards.

It offers laboratory testing services for raw materials and manufactured products. Its capacity includes inorganic, organic, food; polymer and paints; and paper and non-metal analysis laboratories.

It is best placed to monitor the practicality of the standards.

(ix) Water Quality and Pollution Control

The most used risk assessment criteria for chemicals are in water quality for drinking, industries, agriculture, and livestock. Normally, WHO standards are adapted to the local conditions.

The responsibility for water quality is vested in the Water Quality and Pollution Control Division of the Ministry of Water Resources. Its work is facilitated by the Central Water Testing Laboratory which is responsible for raw, potable and waste water analysis. Provincial laboratories in Mombasa, Nyeri, Kisumu, and Kakamega carry out water analysis on a limited scale.

It can offer laboratory calibration and analysis of metals.

(x) Nairobi University

The Universities are the major sources of professionals in the chemical and information use and technology development.

(xi) Centre for Nuclear Science Techniques

This centre conducts research and publishes academic papers on topical issues in chemistry. It has increasingly been involved in monitoring and analysing environmental pollutants. It specialises in elemental analysis; nuclear instrumentation, maintenance, repair and installation; nuclear spectroscopy; dosimetry and non-destructive testing; and information technology. It also undertakes consultancy work for a number of organizations. It has already started a monitoring programme.

(xii) Kenya Energy and Environment Organization (KENGO)

KENGO was founded in 1981, and registered as a coalition of environmental non-governmental organisations in June, 1982. Its policy is to respond to emerging needs of its member organisations and groupings. The membership stands at 220 of which two-thirds are community-based development organisations.

To meet the increasing need for technical information on the management of natural resources and the physical environment, KENGO has been producing simple and practical "How to" publications for frontline extension workers, community groups, schools, farmers and the general public. In-depth reports are also produced for professionals and policy-makers.

(xiii) Climate Network Africa (CNA)

Formed in 1990, CNA is an NGO initiative dedicated to the exchange of information on climate related issues and global atmosphere issues such as climate change and ozone layer protection. As most of ozone layer depleting substances (ODS) are also greenhouse gases, and since alternatives to ODS could have negative implications for climate change, the issues of climate change and ozone layer protection cannot be separated. CNA's work programme is cross-sectoral and hence, relevant to air, water and soil pollution. CNA produces a quarterly newsletter, *IMPACT*, that is published in English and French.

The Newsletter is mailed free of charge.

(xiv) Kenya Consumers Organization (KCO)

KCO is an independent, non-political, non-sectarian and non-profit making national consumer organisation. It is an associate member of the International Organisation of Consumers Unions (IOCU). It operates a network with many NGOs with similar objectives.

KCO's mission is to empower consumers with information through comparative testing and eco-labelling, consumer alerts, and mass action campaigns. It has many sectoral committees. Relevant ones include Standards/Testing, Health and Nutrition; and the Environment Committees.

Table 6.1 Summary of Institutional Air Quality Management

Institution	Present Analytical Capability	Information Dissemination	Enforcing relevant Legislation	Monitoring
IMCE	-	x	x	x
NES	-	x	x	x
NCST	-	x	x	x
DOHSS	x	x	x	x
GC	x	-	x	x
NPHL	x	x	x	x
NCC	x	x	x	x
KEBS	x	x	x	x
WQ&PC	x	x	x	x
KEMRI	x	x	-	x
KIRDI	x	x	-	x
INR	x	X	-	x
KENGO	-	X	-	x
CNA	-	X	-	x
KCO	-	X		x

Note: "x" denotes where facilities are available

6.1.2 Monitoring of Air Quality

It is proposed that an air quality monitoring programme be urgently initiated. In order for compliance and enforcement to be successful, reliable results must be obtained and related to the existing air quality or process in industry over the period for which the measurements are made. Therefore, the objectives of monitoring are to :

- provide information that allows appropriate interventions, such as air pollution reduction, to be made;
- allow periodic surveillance reports on build-up of air pollutants to be made;
- support prosecution cases;
- ensure that enforcement measures are effective; and,
- ensure that non-compliance with the desired air quality is acted upon by the relevant stake-holders such as plant managers, production or quality control engineers, waste auditors, maintenance and plant engineers; health, safety and environmental officers; and sectoral government inspectors.

The establishment of a monitoring programme should go through the stated below stages:

Stage One

(a) Collecting and collating background information relevant to the air pollution problem, including data on types, locations and emission characteristics of stationary sources, the number and types of mobile sources, the meteorological data from existing stations and the distribution of complaints about air pollution.

(b) Establishing contacts with organisations described in Chapter 5 which will play various roles in the programme.

(c) Installing two stations for the measurement of suspended particulate matter and sulphur dioxide. One should be at an urban centre and another at an industrial area, taking into consideration the influence of the meteorological factors.

(d) Setting up meteorological instruments at the two selected sampling sites.

(e) Procuring equipment for the measuring carbon monoxide, from vehicles, work-places and selected residential and service areas.

(f) Procuring a motor vehicle for servicing the fixed stations and carrying out the carbon monoxide survey.

(g) Acquiring laboratory equipment for analysing the levels of suspended particulate matter and sulphur dioxide in air samples.

Stage Two

(a) Continuation of measurements as in the first stage.

(b) Preparation of a simple diffusion model.

Third stage

This involves setting up of an air quality enforcement programme as described below.

(a) Compliance Monitoring

Compliance monitoring will be made at three levels, namely:

Level 1

Routine Monitoring: of the general ambient air quality through measurements and taking an inventory of emission sources. The baseline stations will determine trends in air quality. This will be done by regulatory agencies, research institutions and the universities.

It is proposed that capacity will be developed to have central environmental reporting at regular intervals for decision-making and for issuance of permits.

Level 2

Monitoring Compliance with Standards: The Air Quality Officers will visit the significant emission sources to assess compliance status and identify any equipment, operations or activities that are not in conformity with set regulations.

Level 3

Industry Self-Monitoring: The emission source having better knowledge of activities and processes generating emission will check the air emission and store data and/or reports for onward transmission to the regulating authority. Self-monitoring will either be by process measurement or by emission inventories.

(b) Monitoring Stations

Lead Institution

a Division within the NES or its equivalent will be formed for the enforcement of the proposed standards and guidelines.

The institution will:

(i) create a national database for air quality and referral facilities for management of air quality management;

(ii) create a national referral laboratory for air quality data;

(iii) train air quality Inspectors; and,

(iv) collect and analyse air samples and advise the offenders of the extent of non- compliance with the standards.

Baseline and Impact Stations

Four stations will be created in the following regions:

(i) Mt Kenya Region: This station would most likely monitor background emissions. It is worth noting that, currently the World Meteorological Organisation is setting one of the Global Ozone Observatory Stations under funding from the Global Environment Facility (GEF), in furtherance of the Vienna Convention on the protection of the Ozone Layer. In 1978, there was an effort again by WMO to measure background carbon dioxide. The effort would be complemented by setting a full-fledged station in this locality.

(ii) Coast Region.

(iii) Western Region.

iv) The Rift Valley Region.

Besides being referral centres for the air quality information nationally, the baseline stations will generate data for the regions. The data will be used to assess the pollution load of individual polluters; advise on emission reduction technologies; and response measures by relevant authorities; and to advise on land physical planning to minimize pollution from industrial sources.

6.1.3 Start-Up Activities

The first step is by standardising the methods of measurements for the Central Station and baseline stations as listed below, and reflected inn **Table 6.2.**

- Selection of lead institution;
- Selection of personnel for the lead institution;
- Selection of personnel and training for deployment to the baseline stations; and,
- Procurement of equipment.

6.1.4 Setting Up Monitoring Stations

This will entail the following:

- selection of sampling sites;
- collection of meterological data; and,
- collection and compilation of a comprehensive list of background air pollutant levels.

6.1.5 Impact Stations

The impact stations will be meant for:

- recording the major sources of pollutants for the region under their jurisdiction;
- assessing the practicability of emission standards for the facilities in the region; and,
- periodically monitoring those sources with a view to ensuring full compliance with the standards set for them. Selection of the sites will be based on the criteria stated below.

(i) Representation of the general area selected and the common pollutants;

(ii) Accessibility - 24-Hours a day throughout the year.

(iii) Electrical power availability.

(iv) Security.

Table 6.2 Proposed Start-up program for Setting Air Quality Management

Activity	1st Year	2nd Year	3rd Year	4th Year
1. Setting up of the Air Quality Department.	■			
2. Collection of air quality data from historical records, inventories and *ad hoc* research	■			
3) Identifying facilities likely to qualify for control.		■		
4) Start of training Programmes.				
5) Identifying sites for monitoring stations.		■		
6) Starting the National Air Quality Referral Laboratory.				
7) Setting up initial sampling and analytical programmes.			■	
8) Establishing baseline and impact stations.			■	
9) Analysis and interpretation of data collected.				■
10) Case studies in AQS enforcement.				■

6.1.6 Personnel Development

Table 6.3 Development of Personnel for Air Quality Management

Type of Personnel	1st Year	2nd Year	3rd Year	4th Year
Chemical Engineers	1	2	3	4
Chemists	2	2	3	4
Meteorologists and Physicists	1	2	2	4
Social Scientists	1	1	1	1
Technologists	1	2	2	6
Drivers	1	2	2	2
TOTAL	**7**	**11**	**13**	**21**

6.1.7 Air Pollution Monitoring Equipment and Estimated Costs

An air quality monitoring system will require the following:

(1) a mobile air quality monitoring motor vehicle which can take measurements over a wide area and be adaptable to changing pollutant release systems. Such a vehicle would have to be mechanically stabilised in order to carry the sensitive air quality measuring instruments. It should have the following basic equipment pump, generator, computers, Laser Jet printers, modems, FAX machines/modem and relevant software.

(2) National Air Quality Laboratory (NAQL).

The basic equipment to be procured for the NAQL are shown in **Table 6.4.**

Table 6.4 Equipment for the National Air Quality Laboratory

Equipment	Cost (US $)
Ultra-Violet Spectrophotometer	6000-8000
Infra-red Spectrophotometer	10,000 -15,000
Analytical balance	8,000-10,000
Top loading balance	2,000-3,000
Atomic Absorption Spectrophotometer	20,000-25,000

Instruments will be selected on the basis of the their being cost-effective. **Table 6.5** gives an indicative summary of the estimated costs.

Table 6.5 Indicative Costs for Air Sampling Equipment

Equipment	Estimated Cost (US$)
(i) Portable flue-gas analyzer for CO, SO_2, NOx, temperature, pressure and logging and graphics software	7000-11,000
(ii) Particulate sampling train with associated controls etc.	14,000-24,000
Sampling Pump with range of flows and temperature conditions.	1,500- 3000
Gas flow instruments: Pitot tubes, manometers, gas meters, rotameter and vane anemometers and impingers.	2,000-4,000
Sample collection media: filters, sorbent tubes, impingers, tedlar bags, fritted glass bubblers	500-1,000
Temperature measurement: glass thermometer, thermocouple and electronic thermometers	500-800
pH meter	500-600

6.2 Water

6.2.1 Role and Scope of Key Actors

The main activities, scope/technical capabilities in terms of parameters tested, equipment and personnel necessary for the implementation of water pollution standards were identified as outlined below.

(i) Ministry of Water Resources (MWR)

Water Quality and Pollution Control (WQ & PC) Division

The role of WQ & PC Division is ensuring pollution control, monitoring water quality, control and surveillance of drinking water quality; and water and waste-water analysis. The central water testing laboratory carries out various physico-chemical and bacteriological analysis covering most of the parameters proposed for standardisation, except for detergents, oils and grease; phenols, heavy metals, ammonia, total nitrogen and phosphorus.

The laboratory is well equipped; however, the spectrophotometers and gas-liquid chromatograph are unserviceable, thereby restricting the scope of parameters which can be analysed. There is lack of adequate field testing equipment. The laboratory is not accredited, thus analytical reports cannot be used as evidence in a court of law.

The staffing level at headquarters and in the provinces is adequate consisting of chemists, biologists and laboratory technologists. At district level the personnel are inadequate. More of the personnel need to be gazetted as prosecutors.

The Division has formal and informal collaboration with various institutions including, the Government Chemist Department, Mines and Geology Department, University of Nairobi/Institute of Nuclear Science (UON/INS), Kenya Bureau of Standards (KEBS), and Ministry of Health.

(ii) Government Chemist Department

The main role in water pollution is testing of water and waste-water. The water laboratory is gazetted, is well equipped and is capable of handling all analyses as proposed in Section 5.1.4. The staff consist of analytical chemists and technologists.

(iii) Ministry of Health: Environmental Health Division

The Division, formerly known as the Public Health Department, is responsible for addressing all environmental

health issues as they relate to the well-being of the public including environmental pollution. The Environmental Pollution Section deals with the control and elimination of public health nuisances including formulating standards for their control.

The Public Health Laboratory can handle microbiological and physico-chemical testing of water for surveillance and monitoring purposes; however, the laboratory is not gazetted/accredited. Provincial medical laboratories are equipped to handle water pollution testing. Staff are deployed up to locational level. In the latter case, equipment is lacking and water samples are sent to provincial laboratories or to the national laboratory in Nairobi.

The Division collaborates with Water Department, Government Chemist, Ministry of Environment and Natural Resources (MENR), Kenya Bureau of Standards (KEBS), Housing Department, Ministry of Agriculture and NGOs.

(iv) Mines and Geology Department

The Department has three laboratories that deal with the assay of mineral and rock samples. In addition, water samples are analysed for heavy metals using atomic absorption spectrophotometry. The laboratories are currently experiencing a shortage of staff for their routine work. An additional four chemists, two technologists and two technicians are required. The laboratory is accredited. Other constraints include lack of competent firms to service and maintain the equipment. There is need to train technicians in instrument servicing and maintenance. The Department collaborates with UON/INS, KIRDI, KEBS, among others, on analytical issues.

(v) Nairobi City Council (NCC): Water and Sewerage Department

The NCC has three laboratories. The Kabete laboratory mainly deals with drinking water quality control. The Kariobangi laboratory deals with river water quality monitoring while the sewage treatment works laboratory at Ruai deals with effluent analysis, inspection of industries and enforcement of city bye-laws to ensure compliance with issued guidelines. The laboratories are not accredited and any sample meant to serve as evidence in a court of law is analysed at the Government Chemist laboratories.

The Ruai laboratory tests for BOD, nitrates, ammonia, pH, COD, suspended solids and chlorophyll. Heavy metal analysis is carried out at the Kabete laboratory. The test methods used are from the APHA "Standard Methods" book, 15th edition. The sewage laboratory is under-staffed comprising only two chemists and two technologists. Inspection of industries is constrained by logistical problems such as transport.

Formal and informal collaboration is maintained with the Government Chemist, Kenya Medical Research Institute, MWR, and Habitat, among others.

(vi) Twiga Chemical Industries

Twiga Chemical Industries manufacture fertilizers, bactericides, and veterinary medicines. The company formerly a subsidiary of Imperial Chemical Industries (ICI) Limited, still operates under the corporate environment policy and standards issued by ICI. The ICI standards are more stringent in comparison to the guidelines/standards issued by the Nairobi City Council (NCC). The present effluent quality does not meet the ICI standards, but meet those of NCC for discharge into public sewers. Twiga has a laboratory capable of analysing COD, suspended solids, and paraquat.

(vii) Kenya Agricultural Research Institute: National Agricultural Research Laboratories (NARL)

NARL carries out research in agriculture related fields. The laboratories are well equipped and can handle most of the parameters proposed for standardisation and has adequate staff.

(viii) University of Nairobi: Institute of Nuclear Science (INS)

The INS is a research institution capable of carrying out trace metal and pesticide residue analysis in water using X-ray analysis. The facility is ideal for baseline data collection.

(ix) Kenya Association of Manufacturers (KAM)

Besides representing the interests of manufacturers, KAM acts as a watch-dog on environmental issues and gives technical guidance, education and encouragement to its members to adhere to environmental guidelines. The small team of staff has portable field testing equipment for monitoring effluent water quality.

(x) Kenya Bureau of Standards

KEBS is responsible for setting and enforcement of standards. It has facilities for analysis of water and waste-water it does not undertake pollution control activities.

6.2.2 Training and Equipment Needs

An outline of the training and equipment needs for the institutions involved in implementation and enforcement of the proposed standards is presented in **Table 6.6.**

6.2.3 Collaboration and Pooling of Resources

The national institutions which were visited were found to have established both formal and informal collaboration for sharing of resources. This is especially so with regard to analytical facilities and during the prosecution process. For example, in some cases the Ministry of Water Resources and the Environmental Health Division of Ministry of Health jointly prosecuted polluters under both the Public Health and the Water Acts in order to strengthen their cases. This kind of collaboration should be encouraged and supported to facilitate the successful implementation and enforcement of environmental standards. As mentioned before, a coordinating agency would probably be suitable in enhancing such collaboration.

Table 6.6 Institutional Equipment and Training Needs for Water Quality

Institution/Role	Testing Requirements	Training Needs
MWR - Water Quality and Pollution Control. . analysis . implementation . enforcement . research	Central and provincial laboratories: equipment for analysis of heavy metals, detergents, phenols, oil & grease, ammonia and nitrates District laboratories: equipment for basic tests eg. dissolved oxygen, conductivity, pH, dissolved solids suspended solids	. refresher seminars in practical skills in sampling, preservation and handling of various water testing equipment and quality assurance . skills in carrying out inspections and environmental auditing . bioassessment of water quality for pollution impact monitoring . prosecution course, including: how to acquire and present evidence, law of evidence); water law, criminal procedure law etc.
Government Chemist Department . analysis	none (capable of analyzing all the parameters using the proposed test methods) . analysis usually done on submitted	samples. Training on sampling and preservation techniques and effects of these on analytical results may be worthwhile. Refresher seminars on quality assurance.
Ministry of Health: Environmental Health Division . analysis . implementation . enforcement	At locational level: need field testing equipment for bacteriological and physico-chemical tests	. refresher seminars on practical skills in handling new equipment and sampling and preservation methods
Nairobi City Council: Ruai sewage laboratory	Equipment for heavy metal analysis, detergents, cyanides, sulhpides and phosphorus field testing equipment for surveillance and monitoring	. waste water treatment processes . sampling techniques and test methods for parameters not currently analyzed . skills in carrying out inspections . prosecution procedure . computer data handling
Kenya Bureau of Standards . analysis . review . enforcement	None; capable of analyzing the proposed parameters	. refresher courses in analytical techniques, analytical quality control and assurance
Industries	. implementation Equipment for basic tests depending on effluent characteristics	. training on self-monitoring systems and effluent testing

6.3 Soil

6.3.1 Human Resources Requirements

For the efficient operation of the Soil Testing Laboratory it will require aspects mentioned below.

(i) One National Reference Laboratory with:

- One Head of Laboratory, M.Sc or Ph.D in soil Chemistry or Biology.
- Two Soil Chemists, B.Sc in Soil Chemistry.
- 3 Analysts/Technicians; Higher National Diploma (HND) Level in Analytical Chemistry
- 2 Analysts/Technicians, HND in Analytical Biology.

(ii) One Laboratory in each District/Province with:

- One Head of Laboratory - B.Sc Soil Chemistry.
- Two Analysts/Technicians with HND in Analytical Chemistry.

(iii) Inspectors/Environment Protection Officers:

- Initially one per district - B.Sc in Soil Chemistry.

(iv) Prosecutor:

- Initially to be based at Headquarters, 1 Environmental Lawyer.

(v) Computer Analyst:

- One computer analyst at the Headquarters
- 2 Computer Operators at Headquarters; one per District/Province.

(vi) Equipment Specialists:

- Initially based at Headquarters.
- One Physicist/Electronic Engineer.
- Two Technicians, Diploma in Electronics/ Instrumentation.

(viii) Training Officer:

- B.Ed. in Science, Chemistry, Biology.

6.3.2 Human Resource Development

During the initial stages of institutional building, human resource training needs will mainly consist of attachment to more established testing laboratories, for example, KARI and Ministry of Public Works Materials Department and also to overseas institutions.

Later it will be necessary to have a training department at Headquarters to formulate programmes for university level, polytechnic and on-the-job training; attachment to other institutions; group training, overseas training and creation of public awareness.

6.3.3 Facilities Required

a) Office space to accommodate staff.

b) Laboratory - National Reference Soils Laboratory and Provincial/District Soils Laboratories. The laboratories should be air-conditioned to 23°C ± 2°C. It is proposed that the National Reference Soils Laboratory should be given priority during the initial stages of institutional building.

The preliminary indicative list of equipment for the National Reference Soils Laboratory is as follows:

(i) Soil Chemistry and Biology

Research and Analytical Facilities.

Description

- Laboratory Glassware
- Temperature controlled enclosures
- Ovens
- Light sources (such as white fluorescent tubes) - capable of delivering a constant light intensity of 400 lx - 800 lx at a controlled light/dark cycle of between 12h/12h and 16h/8h.
- Greenhouses
- Conductivity meter

- Analytical balances
- Thermometer
- Shaking machine
- Filter paper
- Desiccator
- pH meter
- Glass electrode and a reference electrode or combined electrode. Scheiber Apparatus, adapted for carrying out a single sample termination
- Reaction vessels, 150 ml capacity with wide neck
- Plastic cap, 10 ml capacity (2)
- Tongs acid-proof(3)
- Watch glass(1)
- Digestion flasks/tubes, 50 ml capacity
- Digestion stand
- Distillation apparatus - Parnas-Wagner type
- Gas chromatograph
- Infra Red Spectrophotometer
- Spectrometer - to measure absorbance in wavelengths up to 900 mm
- Optical cells, of path lengths 10 mm
- Vortex stirrer
- Water bath (2)
- Crushers, mills, mortar and pestle
- Plate sieve, complying with ISO 565, with an aperture of 2 mm1
- Mesh sieve, apertures of 250 µm complying with ISO 5651
- Test sieve, aperture 0.15 mm with gauze cloth made from nylon
- Mechanical sieve shaker
- Mechanical mixer(s)
- Sample divider
- Grinding mill, capable of grinding dried soils, sludges and sediments to sizes less than 150 µm
- Reflux condenser(1)
- Absorption vessel, non-return type
- Roughened glass beads
- Temperature - controlled heating apparatus capable of heating contents to reflux temperature 1
- Funnel, diameter 110 cm
- Atomic Absorption Spectrophotometer
- Drying Oven
- Soxhlet extractor capacity 150 ml.
- Glass fibre filters, diameter 60 mm.
- Chromatography column, with closed circuit.
- Concentration Apparatus, Kuderna Danish or rotary apparatus.
- Gas Chromatograph.
- Chromatography column.
- Data System.

(ii) Information Management - Data Centre

Description/Quantity

- IBM PC Server, 520 8641-SEZ, Pentium 100 MHZ CPU, 64 MB Ram, 6.75 G^6 Hard Disc, 14" SVGA Colour Monitor, Enhanced Keyboard/1
- Epson LQ 1170 printer/2
- HP Laserjet 4M Plus Printer/2
- Victron Micro 1 KVA UPS/1

- HP Scanjet 4C with software/1
- Victron Lite 600VA off-line UPS/4
- Multi-user Lan Software/1
- CD-ROM Drive/1
- Heavy duty Copier/1
- E-mail Software/3
- Ulta 14.4 Fox Modems/2
- Aldus Page Maker V 5.0 Wind1, 5-User
- Network Cards/4
- Printing Adapters and Accessories

It is proposed that a separate consultancy be considered to study laboratory requirements and produce a project document on space and equipment and their costs.

6.3.4 Use of Resources in National Institutions

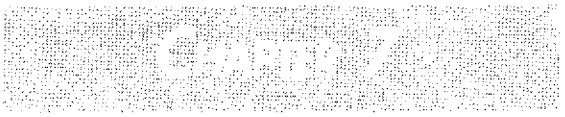
(a) As the districts will be the principle centres for the implementation and enforcement of regulations on environment they will require easy access to testing facilities. It may not be possible to provide these facilities in every district and consideration should be given to accrediting of other testing institutions, including private sector institutions, to provide some of the testing services.

(b) Through the data centre, information exchanges should be developed with other scientific institutions.

(c) The Soils Laboratory, through the proposed National Inter-laboratory Proficiency Testing Scheme to be organised through the KEBS, should regularly compare its results with other testing laboratories.

(d) The laboratory should also organise technical committees composed of experts from itself and other institutions at which scientific and management issues can be discussed.

(e) Exchanges of experts with other institutions should be encouraged.



7.0 REGIONAL CO-OPERATION

7.1 Background

Environmental issues have no political boundaries. Air and water pollution do often have transfrontier effects, a phenomenon that makes a definite case for collaborative and co-operative efforts in the search for mechanisms to manage them.

Besides, Kenya, Tanzania and Uganda share the largest fresh-water lake in Africa, Lake Victoria, whose water quality depends on regional initiatives that must complement the disparate national ones aimed at the management of the polluting riparian activities. National policies, legislation and institutions are by themselves incapable of achieving the best results in air and water quality management, in the absence of co-operative Sub-regional or regional initiatives.

It is therefore important to take into account the existing scope for Sub-regional collaboration in the Eastern African region, in relation to the issues of environmental standards in any endeavour to present a comprehensive picture of the "environmental pollution" problem. The Eastern African region does not only have a common history, but it has also, more recently, been the subject of major initiative with significant environmental implications.

In 1974, the UNEP initiated the Regional Seas Programme which treats 'Oceans" as fundamental units for the protection and development of environmental resources.

Under this programme, the Eastern Africa Action Plan was established, which formed one package with the 1985 Convention on Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region, the Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region, and the Protocol Concerning Co-operation in Combating Marine Pollution in cases of Emergency in the Eastern African region.

This framework of co-operation provided especially through the Convention and the second Protocol, a basis for regional initiatives in issues pertaining to water and air pollution. Articles 7 and 9 of the Convention state thus:

Article 7:

> *"The contacting parties shall..... take all appropriate measures to prevent, reduce and combat pollution of the Convention Area caused by coastal disposal or by discharges emanating from rivers, estuaries, coastal establishments, outfall structures, or any other sources within their territories."*

Article 9

"The Contracting Parties shall take all appropriate measures to prevent, reduce and combat pollution of the Convention Area resulting from discharges into the atmosphere from activities under this jurisdiction."

In addition, Article 11 requires the Contracting Parties to co-operate in taking all the necessary measures to respond to pollution emergencies and to reduce or eliminate pollution or the threat of pollution resulting therefrom. To this end they are required individually or jointly, to develop and promote contingency plans for responding to incidents of pollution or threats thereof.

The general obligation with respect to co-operation is provided for in Article 3 of the second Protocol which requires the Contracting Parties to co-operate in taking all

measures both preventive and remedial, for the protection of the marine and coastal environment of then Eastern African region from marine pollution incidents.

Apart from these arrangements, a new framework for co-operation has been put in place with the establishment of the Tripartite Commission for Co-operation between Kenya, Tanzania and Uganda. The common text on Identified Areas of Co-operation among these states includes the subject of environmental management. As the agreement is thus concerned with the environment as a sphere of regional co-operation, it will be found quite appropriate to incorporate strategies relating to collaborative research and training in environmental standards within the initiatives of environmental management.

Further afield, the 1994 Treaty Establishing the Common Market for the Eastern and Southern Africa (COMESA), provides under Article 4, for co-operation in the development and management of natural resources, energy and the environment, as one of the ways of achieving the aims and objectives of the common market. Chapter 16 of the Treaty (Articles 122-126) has elaborate provisions on the scope and specific areas of co-operation in the development of natural resources environment and wildlife. Article 124 specifically requires the member states of COMESA to co-operate in the management of the environment by taking measures to control trans-boundary air and water pollution arising from the activities within their territories.

It is therefore, to be noted that while the question of environmental management and standards relates more centrally to the domain of national policy and legislation, the logistics of its operationalisation will be found to be substantially dependent on the existence of regional institutions and mechanisms of collaboration.

A Sub-regional workshop was therefore, convened in Kisumu from 2-10 February, 1998, to identify the principles for harmonisation of methodologies for the development of environmental standards. The workshop, which was attended by consultants from Kenya, Uganda and Tanzania considered the essential elements for the national legislation necessary for implementation of the national standards and made recommendations. They also considered recommendations for regional cooperation by the national counterparts proposed here below and gave their recommendations/suggestions as contained the above

Although regional institutions and mechanisms of collaboration are not yet in existence, the current regional initiatives for co-operation in various spheres will ultimately ensure their being put in operation in specific sectors.

REFERENCES

1. Allgemeine Verwaltungsvorschrift uber Mindestanforderungen an das Einteiten von Abwasser in Gewasser (Textilherstellung), 1984. Minister of the Interior, Joined Ministerial Journal.

2. Chapman, D. (ed.), 1992: *Water Quality Assessments.* A guide to the use of biota, sediments and water in environmental monitoring, UNESCO/ WHO/UNEP, Chapman and Hall Ltd., London, 585 pp.

3. Ciaccio, L.L. (Ed.), 1971: *Water and Water Pollution Handbook Vol.1* Marcel Dekker Inc., New York, 449 pp.

4. Ciaccio, L.L. (Ed.), 1972: *Water and Water Pollution Handbook Vol.3,* Marcel Dekker Inc., New York, pp. 801-1313.

5. Development Consultants Limited, 1992: *Rapid Interim Environmental Report for Pan African Paper Mills Expansion Programme at Webuye,* Calcutta, India.

6. Gathuo, B.; Rantalla, P. and Maatta, R.; 1991: *Coffee Industry Wastes.* Water Science and Technology, Vol. 24 No.1.

7. GOK/MCI, 1997: *Sessional Paper on Industrial Development.*

8. GOK/MENR, 1992: *Draft Clean Air Bill.*

9. GOK/MENR, 1994: *Kenya National Environment Action Plan Report, Nairobi.*

10. GOK/MENR, 1994: *Kenya National Master plan, Nairobi.*

11. GOK/MENR,1995: *Draft National Policy Paper on Environment.*

12. GOK/MENR, 1996: *Draft Environmental Management and Coordination Bill.*

13. ILO, 1980a: *Occupational Exposure Limits for Airborne Toxic Substances. Occupational Safety and Health Series, No.37,* International Labour Organisation.

14. ILO, 1980b: *Code of Practice on Occupational Exposure to Airborne Substances Harmful to Health.* ILO Code of Practice, International Labour Organisation, Geneva.

15. ILO, 1982: *ILO Official Bulletin,* Vol. LXV, Series a, No.3, International Labour Organisation, pp. 132-133.

16. ILO, 1996: *African Newsletter on Occupational Health and Safety,* pp. 46-49.

17. IPCC, 1994: *Guidelines for National Greenhouse Gas Inventories,* Reference Manual Vol.2.

18. JICA/GOK, 1992: The Study on the National Water Master Plan. Sectoral Report (N); Environmental Conservation. Japan International Cooperation.

19. Legislacao Federal Control da Poluicao ambiental, 1993, CETESB, Brazil

20. Meybeck, M. and Helmer, R., 1992: An Introduction to water quality. In Chapman, D. (ed.),Water Quality Assessments. a Guide to the use of biota, sediments and water in environmental monitoring, UNESCO/WHO/UNEP, Chapman and Hall, London, pp. 1-17.

21. Tamil Nadu Pollution Control Board (India), 1989: Pollution Control legislation. India

22. UNEP, 1992: Agenda 21, Chapter 8.

23. UNEP, 1996: Industry Environmental Compliance Training Manual. Technical Report No. 36, United Nations Environment Programme Industry and Environment Centre, Paris, France.

24. UNEP, 1996: Framework for Information Management in the context of the Convention on Biological Diversity, Second Edition. Biodiversity Data Management Project, United Nations Environment Programme and the World Conservation Monitoring Centre, 86 pp.

25. UNEP/UNIDO, 1996: Monitoring Industrial Emissions: Technical Report NO.27; pp16-17.

26. UNIDO, 1991: Working Paper No 2. The Road to Sustainable Industrial Development.

27. WHO, 1976: Manual on Urban Air Quality Management, Regional Publications, European Series No.1.

28. WHO, 1977: GEMS/Air Monitoring Programme Design for Urban and Industrial Areas.

29. WHO/UNEP, 1989: Human Exposure Assessment Location Project-Indoor Air Pollution Study, Maragua Area, Kenya, WHO, Geneva, pp 11-18.

30. WMO, 1993: Technical Document No.553. Global Atmosphere Watch Guide No.86.

31. Victoria Government (Australia), 1988: Special Gazette, No. 513.

32. Ministry of Science, Technology and Environment, Malaysia 1990.

TANZANIA COUNTRY REPORT

EXECUTIVE SUMMARY

INTRODUCTION

The Study on the development and harmonization of environmental standards involved review of policy and legislation on the environment and on the basis of a number of recommendations which have been given for effective implementation of the standards.

In this regard, this Report comprises the following:

- Identification of priority areas relevant to formulation of environmental standards and guidelines and explained why.
- Review of all existing environmental standards and guidelines relating to the sectors identified.
- On the basis of existing relevant scientific knowledge and local consultation on standards, developed environmental standards to fill the gap where no regulations exist and formulated proposals for amendments.
- Recommendations for amendments necessary capacity-building requirements.

The Report further reveals that in Tanzania there are over fifty pieces of legislation

on environmental issues in the statute books.

In addition, to those legislation, there are also principles of common law which could be applied by the Courts to address questions of environmental protection. These include the tort of nuisance, and the Rule in Rylands Vs. Fletcher. Needless to say, there has been very little litigation based on those principles in Tanzania.

As regards legislation, the finding in the report reveal that most pieces of legislation consist of generalized categories which are not easily enforceable in courts of law, since they do not stipulate environmental standards which can be used in court litigation or other forms of enforcement. It is only the Water Utilization (Control and Regulations) Act, No. 42 of 1974 as amended by Act No. 10 of 1981, which sets standards for water (temporary).

One would be right to assert that there are no standards for air quality (with the exception of the what is stated in Section 310 of the Merchant Shipping Act, 1967); and there are no standards that exist for soil quality.

In addition, the report states that even in the few instances where there is clarity as regards environmental standards/ guidelines, the punitive provisions are not deterrent enough.

RECOMMENDATIONS

The issues addressed in this report have the following recommendations.

- *Enact Framework legislation on the environment*

Through the framework legislation the National Environment Management Council (NEMC) should be given powers by law, to promulgate standards and enforcement which could be carried out by sector ministries under the supervision of NEMC. In this respect, adequate legal provisions on standards should be in place in the forthcoming framework environmental law.

The framework legislation should make EIA mandatory for every project likely to contravene environmental standards. Standards should represent minimum requirements, but should not preclude the application of additional requirements after EIA has been carried out, to reflect the sensitivity of certain elements or receptacles in the environments.

The framework law should have a provision on imposition of performance bonds which may be forfeited if the set environmental standards are violated.

The framework law should empower NEMC and the courts to issue environmental restoration orders in case the environment is degraded as a result of contravention of environmental standards.

- *There has been very limited emphasis on environmental protection by way of court litigation*

Stream-line the judicial process by making public interest litigation less cumbersome. This will fill the gap left by environmental institutions and avoid conflict of interest where the polluter is the Governmental or its agency. It is also recommended that the judiciary should consider holding special sessions on environmental matters.

Environmental Institutions be given powers to prosecute violators.

Awareness raising at different levels on environmental standards and effects of environmental pollution. At least environmental issues should not be considered confidential or classified information.

Enforcement mechanisms on environmental aspects should be decentralized and will devolve on local levels.

The residents of the three East African states be given the right of access to each state's judicial and administrative systems to seek remedies for environmental damage caused by trans-boundary activities which relate to violation of the agreed standards. This issue be handled or addressed in a protocol or memorandum of understanding among the three countries.

- *In the few instances where there is clarity on environmental standards/guidelines the punitive provisions against violators are not deterrent enough*

Stiffen criminal and civil penalties for pollution and make them adjustable to inflation trends.

The framework law should empower NEMC and the courts to issue environmental restoration orders in case the environment is degraded as a result of contravention of environmental standards.

Require owners of facilities which are likely to cause pollution to keep environmental records. Environmental inspectors need to go through such environmental records in order to assess compliance with set standards.

Institutionalise both periodic- and spot - inspection and make effective use of the existing inspectors; and initially start with the major polluters due to lack of resources.

- *Lack of environmental standards and failure to up-date them in line with scientific and technological advancements*

There is need to recruit qualified technical staff to work on the eligibility of an applicant to obtain pollution licences, and to monitor adherence to set conditions/standards. In this regard, the government ought to respect professional advice given thereof.

Make provision for regular review and up-dating of standards and the introduction of new standards.

Establish a joint committee on standards for the East African Sub-region, as a sub-committee under the framework of the East African Cooperation. Re-think the re-establishment of the East African Bureau of Standards.

CHAPTER 1

1.0 INTRODUCTION

The objective of environmental protection can only be achieved through a process in which pre-set environmental controls are effectively implemented. The setting of environmental quality standards is one of the common approaches towards protection of human health and the environment. Different terms such as criteria, guidelines, objectives and standards are normally used to depict the controls that are usually incorporated in legal instruments governing the environment and tend to have a normative and binding effect. Such controls, however, are not self executing.

For the controls to be effective, a corpus of environmental laws in which those controls are in-built, must be adopted through a machinery in which the regulator and the regulated have conceded the need for environmental regulation. Involvement of stake-holders in the setting of environmental standards is vital especially in jurisdictions which do not provide incentive for compliance but rather, depend solely on "command and control" approaches.

Admittedly, the fact that environmental controls are needed, reflects the reality that this country has been operating without such controls and thus, posing a threat to the environment. Therefore, a precursor to the imposition of environmental protection requirements relating to pollution sources, should be creation of awareness on the need to significantly adjust the behaviour of owners of industries, individuals and government agencies. In addition, implementation of environmental controls relies upon a strong and credible framework of environmental enforcement, which includes: effective licensing and monitoring system; taxation; fines; effective judicial processes; fines; closure of facilities and imposition of criminal penalties on the violators.

For purposes of this report, the terms used are defined as follows:

"guidelines" means numerical limits or normative statements which are set to support and maintain designated uses of the environment and human health,

standards" means fixed maximum limits to exposure, and/ or emission of, certain chemicals that are recognised, in enforceable laws by one or more levels of government. Standards do also include threshold (limits) values for air-borne concentrations of industrial chemicals at work-places.

1.1 Policy and Legislation: Objectives and Reasons.

Hitherto, Tanzania has no standards directly controlling emissions to the environment. So far, standards have been developed on water quality, worker safety and consumer goods. Some of these standards are temporary. The National Environmental Management Council (NEMC), however, has been working on the development of water and air standards in collaboration with other agencies.

1.1.1 Draft National Environmental Policy

The draft National Environmental Policy (NEP) is a reflection of the country's commitment to environmental regulation. The NEP outlines the major environmental protection goals which includes the setting of environmental standards and indicators. It does also seek to reduce and control impacts of industrial emissions through location planning, control of emissions and the use of clean or environmentally sound technology. The policy also seeks to establish permissible noise levels in cases of noise-prone industries and to control air pollution from industries.

Paragraph 114 of the NEP provides that environmental indicators shall be defined, for example, on land-use conversion ratio (rural/urban, wetland/agriculture, forest/agriculture, among others), in order to gauge possible stress/resiliency on ecosystems. The policy asserts that standards and indicators are necessary management tools for providing early-warning relating to potential environmental problems and assimilative capacities of environmental media and quality habitat.

Since standards are set as instruments of environmental law, an explicit policy backing is indispensable. In Tanzania, the draft National Environmental Policy (NEP) recognises the need to have, inter alia, environmental standards and indicators, as instruments for environmental policy. Below are priority policy instruments as proposed in the NEP.

(a) Environmental Impact Assessment

Environmental Impact Assessment (EIA) is taken by NEP to be a decision-making tool enabling decision-makers to not only tackle immediate environmental problems, but also take precautionary, and preventive approaches as the most effective and economical measures in achieving environmentally sound development.

The main objectives of EIA are to:

- inform or enlighten decision-makers, so that decisions are made as to whether the proposed projects are permitted, based on proper consideration of the environmental implications of such proposed projects; and,
- ensure that environmental considerations do not become an after-thought in project planning and decision-making , but rather, form an integral part of the process, and provide a vehicle for public awareness and debate on the development proposal.

The policy advocates for guidelines and specific criteria to be developed for EIAs in Tanzania.

(b) Economic Instruments

Tanzania, like other East African countries, is moving into a fully-fledged market economy. The role of the private sector in the economy has also been immensely augmented on one hand and, whereas on the other hand the government retains the regulatory role.

Undoubtedly, this will endeavour to balance use of regulations and appropriate economic instruments for environmental conservation which has effective elsewhere. Advantages of using market-based approaches for environmental conservation include their:

- potential for attaining a specified level of environmental protection at a minimum cost; and,
- ability to directly involve key players in the market circle namely, the producer and the consumers, by making the two categories of players pay directly for environmental protection measures in respect of production and consumption of goods and services.

Effectiveness of market approach, however, is dependent on the strength of the regulatory framework. The Government, which normally reserves the role of a regulator, ought to ensure that the market forces are used for the betterment of the environment.

A number of economic instruments may be suggested, but the conventional ones include:

- agreements between the regulatory authority and industry committing the latter to abide with regulations and clean up effluents they have discharged at their own cost.
- use of licences and permits and financial incentives to develop and use cleaner technologies.
- introduction of green-taxes which aim at gauging the use of natural resources, and reflects the value of the environment.

(c) Environmental Standards and Indicators

Establishment of environmental standards and indicators is taken by NEP to be one of the key policy instruments reflecting the degree of acceptable stress on the environment.

The draft NEP outlines its objective in the water sector to be that of making sure that, the overall national goal of providing safe and clean water and to satisfy other water needs, will be fulfilled. Undoubtedly, that calls for the development of lucid and enforceable water quality standards.

With regard to other environmental management considerations, the draft NEP stresses that standards and indicators should be developed, in order to achieve different objectives which include:

- enhancing access to statistical, scientific and technical information by non-user groups;
- developing discipline indicators outlining pre-set measurements and thresholds pertaining to an environmental issue; and,
- formulating aggregated and policy-oriented indicators based on various disciplines to enhance sound decision-making.

(d) Environmental Legislation

The legal instruments on the environment are taken as important policy components for the entire environmental management framework. This is so because laws set priorities, limits, impose a binding effect and duties, and therefore, are capable of governing the entire pattern of environmental management.

NEP acts as a precursor to the evolution of framework environmental legislation, which will take into consideration the structure and division of government functions and multiple stake-holders involved in the various sectors affecting the environment. The NEP, however, stresses that for environmental legislation to be effective, environmental standards and procedures have to be in place.

(e) International Co-operation

Management of the environment is not limited by geographical borders. Indeed, even the current UNEP/ UNDP East African Sub-Regional Project on Environmental Law and Institutions, is an outcome of the recognition that there is need to join efforts in conserving the environment at the regional level. The draft NEP recognises the need for international co-operation in taking into consideration ecological relationships between nations.

(f) Precautionary and Preventive Measures

The Earth Summit in Rio de Janeiro, in 1992, urged states to abide by the precautionary principle, on the basis that knowledge and scientific information on the effect of environmental impacts may at times be incomplete or unavailable. Precautionary principle, is therefore taken as a policy instrument to enable decision- makers to take steps, in certain cases, in order to protect and enhance environmental integrity, notwithstanding the dearth of information or knowledge of the effects involved.

1.1.2 Setting Of Environmental Standards Under the Existing Legal Framework

Section 4 of the National Environmental Management Act (1975), provide that one of the mandatory duties of the NEMC is to specify standards, norms and criteria for the protection of beneficial use and the maintenance of the quality of the environment.

In addition, the law gives mandate to NEMC:

> "*... to evaluate existing and proposed policies and the activities of the Government directed to control of pollution and the enhancement of the environment, and to accomplishment of other objectives which effect the quality of the environment, on the basis of that formulate policies and programmes which will achieve more effective management and enhancement quality.*

This particular mandate given to NEMC is wide. NEMC will undoubtedly need to prioritise its standard setting responsibilities. It is advisable, however, for NEMC to focus first on sources of pollution posing the greatest threat to human health and environment. Standards on air, water and soil are some of those that will need to be prioritised because, the quality of these environmental media has far reaching implications on the health, well-being and survival of the people of Tanzania.

Although NEMC has been directed by its establishing Act to specify criteria, norms and procedures for measuring air, water and soil quality, among others, these will only be effective if their formulation is a result of joint efforts by various stakeholders. The law should also specify who should have the mandate to enforce those standards.

CHAPTER 2

2.0 REVIEW OF STATUTORY STANDARDS AND GUIDELINES ON ENVIRONMENT

Although environmental issues of recent have became very topical, laws of Tanzania, in various forms tend to address environmental concerns even if not in a comprehensive and coordinated way. Over fifty principle pieces of legislation in Tanzania statute books focus on the issues of environment in their totality, by addressing man's physical surroundings (air., water, land, plants and life generally). Those pieces of legislation have enforceable rules and principles regulating anthropogenic activities which impact on the above mentioned surroundings.

In addition to statutes, the principles of common law as received in Tanzania, also address the questions of environment through the torts of nuisance, negligence and the rule in Rylands v. Fletcher. Tortious litigation relating to matters of environment in Tanzania, however, is hard to come by since recorded litigation which is relevant to environment was based on aspects of administrative law.

Outside Tanzania, and within the Commonwealth, environmental litigation based on common law principles of tort abound, would constitute persuasive authorities to Tanzania courts on similar matters. Australia, India, Pakistan and Malawi are some of the countries where the common law litigation on torts have taken place.

The remedies available under the law of tort, however, are in the realm of private law, and it is up to affected citizens to sue under the law of torts; and this depends on the awareness of the concerned individual's rights and the will and ability to pursue such rights through courts.

As observed above, private litigation on matters of environment is a rarity in Tanzania, and therefore, pollution cannot be tackled effectively under private law.

- *Examples of Legislation, (Principle And Subsidiary) Prescribing Environment Standards and/or Guidelines*

In this context, "standards" mean specific limits fixed by law, which prescribes the amount of pollution of the environment which is permissible, or specific qualitative measures to be achieved with the intention of protecting the environment.

The practice among environmentalists is to divide environmental standards into:

(a) Ambient Standards

Ambient Standards are standards set for purposes of addressing the effects of discharges into the environment; they set the maximum pollutant concentration permitted in the environment.

An example of ambient standards is that found in the Water Utilization and Control Act of 1974, where the quality of water-receiving bodies is set.

(b) Receptor Standards

Receptor Standards are aimed at dischargers (polluters) whose activities harm the environment. Examples of legislation addressing such standards are: Section 184 of the Penal Code which makes fouling of water a misdemeanour; and, Section 185 of the same Penal Code which similarly makes fouling of air a misdemeanour.

(c) Emissions Standards

Emission standards set permissible emissions which are less harmful to man and his environment. An example of emission standards are those set by the Water Utilization

and Control Act, which sets standards in respect of effluent discharge into receiving waters.

(d) Specification Standards

Specification standards are those that regulate industrial activities with a view to avoid or minimise environmental pollution arising therefrom. These standards prescribe materials which may be used in construction or manufacturing activities/industry.

2.1 Water Standards/Guidelines

2.1.1 Water Works Ordinance

The Water Works Ordinance specified that pollution of water supplies in certain instances is a criminal offence.

Limitation

The Ordinance does not define clearly what constitutes pollution, apart from merely stating that the water becomes "unwholesome".

2.1.2 Urban Water Supply Act

The Act gives the Urban Water Authority powers to make rules regarding surface and ground water pollution, and set punishment for the same. The Act, however, is specific to Dar es Salaam since the latter is the only designated urban centre under the Act.

Limitation

Although the Act addresses urban water supplies, and is silent on rural areas where more than half of the population is based, it only covered Dar es Salaam, largely because the other urban centres have not yet been specified to receive these services.

2.1.3 The Water Utilization (Control And Regulations) Act No. 42 of 1974 as Amended by Act No. 10 of 1981

This is the major legislation on water in Tanzania. The Act vests all water in Tanzania, in the Government, for the benefit of all the people in Tanzania. It accordingly upholds the inherent right of every one to use the water.

(a) Water Rights

The Act also established control and regulatory mechanisms to engender the main objective of water availability to everyone, however, where water is required for industrial, agricultural, forestry or mining activities, the user shall have to apply for water rights. Under Section 15 the applicant should state the use of the water, amount required, period of use, among other needs.

The Water Officer, in granting a water right, should give conditions and directions for safe use of the water. Safe use, if it is granted, should be interpreted to mean avoidance of pollution of the water while it is being utilitised. Where the water is returned into a river or lake, the right-holder shall ensure that the water so returned shall be substantially undiminished in quality. To achieve this, the rights-holder is required to treat the water in such as manner as to comply with prescribed effluent and receiving water standards. The Act sets the standards which form one of the schedules to the Act. The set standards are still temporary (they have remained so for almost 20 years now).

(b) Discharge From Commercial and Industrial Systems

To ensure compliance with the set standards, the Act prohibits discharge of any effluents from commercial and industrial sources into receiving waters, except with a permit and in accordance with the said set standards.

The Law prohibits discharge from commercial, industrial or trade systems into receiving waters without the consent of the Water Officers. Discharging in this case includes discharge into- underground strata. The law also bans any discharges from industrial or commercial systems into any area within 230 meters from a borehole, well or other water-hole.

Where the Water Officer gives his consent, the consent-holder must meet the standards for effluents as set by the Act. In this case, the Act sets two standards for effluents (end of pipe standards), namely, those for direct discharge into receiving waters; and, those for indirect discharge via municipal treatment works.

On receiving waters, the law has identified three categories:

- water suitable for drinking, swimming, food and beverages, manufacturing industries, and other industries which require water of similar quality;
- water suitable for use in feeding domestic animals, in fisheries, shell cultures, recreation and water contact sports; and,
- water suitable for irrigation and other industrial activities requiring water of standards lower than those stated above.

The Act also establishes temporary standards of quality of domestic water. In view of the fact that domestic water is not defined by the Act, it would be safe to place all kinds of human and domestic use under this category.

The Act has prescribed a punishment of T. shs 50,000 for water pollution or T. shs. 100,000 or subsequent conviction of five years imprisonment. According to Section 33(4) of the Act, punishable pollution is said to be committed when it is likely to cause injury directly or indirectly to public health, livestock or fish, crops, orchards or gardens.

Limitation

Curiously enough the Act does not base criminal liability on failure to observe the standards, instead criminal liability is bases on the likelihood of causing injury, a yard-stick which is not readily discernible.

2.1.4 The Public Health (Sewerage And Drainage) Ordinance (Cap.336)

The law empowers urban authorities to prohibit discharge of certain substances into public sewers. In this regard, it has to be read together with Local Government (Urban Authorities) Act, 1982.

2.1.5 The Fisheries Act, 1970

The Fisheries Act, the Fisheries (General Regulations), 1973, the Fisheries (Explosives, Poisons and Water Regulations), 1982, and Fisheries Regulations, 1989, inter alia, ban the flow or passing into water of any solid, liquid, or gaseous matter or cause water pollution in any lake, river, dam, estuary or sea water. (Reg. 27(1) of Fisheries Regulations, 1989).

The person responsible for pollution is required to clean the polluted water within a reasonable period at his own expense. This is the polluter pays principle.

Limitation

It is not easy to apprehend the polluters as monitoring resources are not available, for example, recently where the army had to be asked by the Vice President (whose office supervises environmental affairs) to assist in rooting out dynamite fishing.

2.2 Air Quality Standards/Guidelines

2.2.1 The Penal Code (Cap. 16)

Section 185 of the Penal Code stipulates that:

> *"Any person who voluntarily corrupts or fouls the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carrying on business in the neighbourhood or passing along a public way is guilty of a misdemeanour";*

and shall be punishable with imprisonment for a term not exceeding 2 years or with a fine or both.

Section 186 adds that any person who for purposes of trade or otherwise makes offensive unwholesome smells in such places and circumstances as to annoy any consideration number of persons in the exercise of their common rights, commits an offence. The punishment for this offence is the same as for a common nuisance under the Penal Code whose punishment does not exceed one year imprisonment.

Limitation

It is not easy to convict under the above sections since no standards have been set to determine what is noxious and what is not. Moreover the prohibition under the law is not strict since it is only punishable when the pollution is voluntary.

2.2.2 Local Government (District and Urban Authorities) Acts, No. 7 and 8 of 1982

Local governments, under both Acts are enjoined amongst their functions to take all such measures necessary, desirable, conducive or expedient "for furtherance and enhancement of the health, education, and the social, cultural and recreational life of the people"[1] and "to provide for the prevention and abatement of nuisances which may be injurious to public health".[2]

The two Acts, that is, Acts No. 7 and 8, are broad enough to empower the District and

Urban Authorities to regulate pollution problems, including air pollution.

1 (Section 54(1)(c) of Act No. 8)

2 (Section 55(1)(1) of Act No. 8 of 1982). See also Sections 111(2)(c) and 118(4) of Act No. 7 of 1982.

Limitation

None of the Local Governments has addressed questions of air pollution. In fact one of the urban authorities had to be taken to court for air pollution in a civil suit filed by residents.

No emission standards have been set by any of the Local Governments, powers granted by the law not withstanding.

2.2.3 The Merchant Shipping Act, 1967

The Merchant Shipping Act prohibits any ship within the limits of a port to emit dark smoke, soot, ash gut, or gritty particles, for a period in excess of five minutes in any one hour. The Act defines dark smoke as smoke which, if compared in the appropriate manner with a chart known as *"Ringalmann Chart'* would appear to be as dark as or darker than shade 2 of the chart.

Limitation

The above standard as set out under Section 3 1 0 of the Act, is of very limited efficacy as most of the air pollution in Tanzania does not arise from the sea. Indeed there is no record of any prosecution under the Act, leave alone the fact that punishment for offences under the section is inconsequential.

2.2.4 The Tanzania Bureau of Standards Act No. 3 of 1975

The Tanzania Bureau of Standards (TBS) is basically concerned with setting standards for industrial products. There is, however, a suggestion that TBS can influence or minimise pollution by only issuing standard marks to those manufacturers who use appropriate production processes.

Limitations

TBS and the legislation generally are not meant to establish and monitor environmental standards.

2.2.5 Protection from Radiation Act No. 5 of 1983

The main objective of the Act is to protect the environment and human beings from harm resulting from ionising radiation. To achieve this objective, the Act establishes under Section 5(l), a Commission to control the use of radioactive and radiation devices. The Commission's functions include:

- advising/informing the Government on the proper use of ionising radiation and how to protect the public;
- controlling the importation, movement, storage, and use of radioactive devices, installations and other radioactive materials;
- licencing importation and use of radioactive devices and materials; and,
- keeping a register of importers and users of nuclear and other radioactive plants and materials (Section 7(l).

Exceptions to the above are provided through exempting licensing and registration of importers and users whose radioactivity does not exceed a set threshold. In this case the standard set is 'A micro *curie.*

Limitation

Atmospheric pollution through radiation is probably not yet a major problem in Tanzania though, there have been two criminal cases under the legislation in the last two years; however, there is no recorded conviction. Furthermore, there is no sufficient human and technological resources to monitor radioactivity in the country in the event that anybody is convicted of contravening the Act, the punishments prescribed in the Act are very low since the highest sentence is still T. shs 100,000 or five years imprisonment in default.

CHAPTER 3

3.0 REVIEW OF SCIENTIFIC KNOWLEDGE AND TECHNOLOGY ON ENVIRONMENTAL STANDARDS

The task of deciding the amount of pollutants a community might reasonably be expected to discharge in water, air or the land is highly complex. It must take into account many factors, including conflicting interests.

On the one hand, development demands the use of natural resources, but on the other hand, there is an optimum level beyond which negative effects can be accepted. Tanzania is blessed with a rich variety of natural resources, big and small, which must be protected. The rich variety of nature must be preserved as well as safe-guarding the human health. Through knowledge and experience a well balanced ecosystem must eventually be given priority.

The draft National Environment Policy for Tanzania is being reviewed with the aim of ensuring that sustainable development is one of its broad objectives. One of the broad objectives of the policy is to ensure and control degradation of land, water and air which constitute our life-supporting systems.

3.1 Water Standards

The standards being proposed specifically aim to achieve the protection of human health, living resources and ecosystems, amenities and other legitimated uses of the environment, from negative impacts resulting from pollution. The beneficial uses which need protection include, among others, drinking water sources and supplies, irrigation, fisheries and recreation.

Each of the beneficial uses of water require certain quality characteristics which are usually specified in applicable criteria. To achieve this, it is necessary to select the most reasonable level of each criterion so as to come up with a number of criteria viewed as specifications describing the overall water quality recommendations, including the safety margins, inherent in each criterion. This has involved review of studies carried out in various parts of the world with regard to heavy metal toxicity and safety margins **(see Table 3.1)**, effluent standards, receiving water standards and drinking water standards, applicable to different countries **(Tables 3.2 and 3.3)** and finally an evaluation of the Tanzania temporary effluent standards **(Table 3.4)**.

Considering limits allowable for waste waters, different scenarios were considered and discussed, for example, an dilution at the centre of big water bodies like lakes Tanganyika or Victoria, and other small water bodies. By assuming extreme environmental conditions (that is minimum flows and maximum temperatures likely to be encountered) and minimum waste-water dilution factors (in some cases as low as 10) for the limited water bodies, a number of specifications were derived.

3.1.1 National Standards on Municipal and Industrial Effluents

The on-going process of proposed discharge limits, is attempting to ensure that each industry has to comply with precisely the same minimum environmental requirements governing discharges.

To begin with, all industries in the country have been put on equal competitive basis as far as environmental precautions are concerned.

In future, industry specific limits will be considered in separate standards, to take care of volume of discharge,

concentrations of industries in one area, and discharges peculiar to specific industries.

So far, attention is mainly being focused on waste-water limits because of its potential to pollute water bodies. The waste-water standards are single level/stage, fixed centrally and apply to all discharges throughout the country. They are meant for production techniques and more effective techniques of waste management and disposal. They are set to provide more safety margins without unreasonable specifications of levels of discharge; and they seek to achieve and maintain quality of water in all water bodies in Tanzania, at levels suitable for various uses.

In most parts of the country there are no treatment facilities for waste-water; and for some of the municipalities and industries attempting to carry out water treat, the processes are not effective enough due a varied number of reasons. For this reason, more attention has been given to discharges which flow directly into water bodies, presumably without (adequate) treatment. As such, most limits assume this scenario.

Table 3.1: Relative Mammalian Toxicity of Elements Injected Doses and Diet.

Element	Acute lethal doses (LCD50) Injected	Doses in human diet (mg/day) into mammals * (mg/kg body weight)	
		Toxic	lethal
Arsenic (As)	6	5-50	50-340
Baruim (Ba)	13	200	3.7k
Cadmium (Cd)	1.3	3-330	1.5k-9k
Cobalt (Co)	50	500	-
Chromium (Cr)	90	200	3k-8k
Copper (Cu)	-		175-250
Mercury (Hg)	1.5	4.0	150-300
Nckel (Ni)	110-220	-	150-300
Lead (Pb)	70	1	10k
Zinc (Zn)	-	150-600	6k

*Injected into the peritoneum to avoid absorption through the digestive tract. Chemical from any of the elements will affect its toxicity.

Source: B. J Alloway: Chemical Principles of Environmental Pollution.

Table 3.2: Proposed Tanzania Wastewater Standard (With Specific Reference to Heavy Metals of Other Countries Compared to Effluent Standards

Metal	Tanzania	Malawi	India	Czech Rep.	Canada	Germany	Japan	USA
Aluminum	2.0		-	3.0	0.1		-	-
Arsenic	0.2	0.2	0.2	0.5	0.1		0.5	5.0
Barium	1.5	-	3.0	-	-	1.0	-	
Cadminium	0.1	2.0	2.0	0.5	0.1	0.005	0.1	1.0
Chromium (IV)	0.1	0.1	0.1	1.0	0.1	-	0.5	-
Chromium (total)	1.0	-	2.0	1.0	0.5	2.0	1.0	
Cobalt	1.0	-	-	1.0	0.1	0.1	3.0	-
Copper	2.1	3.0	0.1	1.0	0.1	-		
Lead	0.1	0.1	0.01	0.5	0.1	0.05	1.0	5.0
Mercury	0.005	0.01	3.0	0.2	0.001	0.001	0.05	0.2
Nickel	0.5	3.0	5.0	1.0	0.5	0.05	-	
Zinc	5.0	5.0	2.0	0.5	-	5.0		

Table 3.3: Guideline and Maximum Acceptable Concentrations for Metal Pollutants in Drinking Waters. (Concentrate in @zg/1)

Element	EC/W'HO	Canada	USA
Arsenic	50(W)	25	50
Barium	too	1000	-
Cadmium	5	5	10
Chromium	50(w)	50	50
Copper	< 3000	< 1000	1000
Lead	50(W)	10	5
Mercury	l(W)	1	1
zinc	< 5000	< 5000	5000

Source: *B.J. Alloway: Chemical Principles of Environmental Pollution.*

Table 3. 4 (a): Tanzania Temporary Industrial Effluent Standards

Physical Characteristics	Unit	Effluent for direct discharge to receiving water. maximum permissible limit	Effluent via municipal sewage treatment plant to receiving water: maximum permissible limits
Suspended Solids	mg/1	not to cause formation of sludge or scum in receiving water	no limit
Colour	number (Pt-Co)	not to cause any change in the natural taste or odour of the receiving water	100
Tase and Colour	-	not to cause any change in the natural taste or odour of the receiving water	-
Temperature	°C	not to cause any increases of the receiving water by more than 5°C	35°C or not more than 5°C above ambient temperature of the supplies water - whichever is greater
Total Dissolved solids	mg/l	3000; no restriction for discharge into the sea	7500
pH	mg/l	6.5 - 8.5	
Nitrite (No_2)	mg/l	1.0	10
Phosphate (PO_4^{2-})	mg/l	600	600
Sulphide (S^{2-})	mg/l	0.5	1.0

Table 3.4 (a) (continued): Organic Substances

Alkyl benzyl sulphonate	mg/l	2.0	5.0
Aromatic nitrogen containing compounds (e.g. aromatic amines)	mg/l	1.0	5.0
Chloroform extract (CE)	mg/l	0.05	0.05
Fomuldehyde	mg/l	5.0	10
Grease and oil (petroleum ether extract)	mg/l	1.0	1.0
Non-volatile chlorinated compounds (CIL)	mg/l	5	20
Organochlorine pesticides (a) (CI)	mg/l	0.05	0.05
Other pesticides	mg/l	0.005	0.005
Phenols	mg/l	0.01	0.01
Rasins, tar, etc	mg/l	0.2	1.0
Volatile chlorinated Hydrocarbons (CI)	mg/l	2.0	5.0

Table 3.4 (b): Receiving Water Standards

Physical Characteristics	Unit	Effluent for direct discharge to receiving water:	Effluent via municipal sewage treatment plant to receiving water: maximum permissible limit
BOD, 5 days 20° C	mg/l	30	-
BOD, 5 days 5° C	mg/l	34	no limit
BOD, 5 days 30° C	mg/l	37	no limit
BOD, 5 days 35° C	mg/l	40	no limit
Permanganate value	mg/l	80	no limit

Note: *The receiving water standards would apply to any water body into which any effluent discharges. These standards have an overriding predominance and any effluent discharging into a water body, should be seen not to pollute the receiving water entirely.*

Table 3.4 (b) (Contd): Chemical Characteristics

Aluminium (Al)	mg/l	2.0	5.0
Arsenic (As)	mg/ l	0.1	0.1
Barium (Ba)	mg/l	1.5	3.0
Cadmium (Cd)	mg/l	0.1	0.1
Chromium (Cr^{+})	mg/l	0.1	2.0
Chromium (Cr^{+})	mg/ l	0.1	0.2
Cobalt (Co)	mg/l	1.0	1.0
Copper (Cu)	mg/l	1.0	1.0
Iron (Fe)	mg/l	3.0	5.0
Lead (Pb)	mg/l	0.2	0.2
Manganese (Mn)	mg/ l	3.0	5.0
Mercury (Hg)	mg/l	0.005	0.005
Nickel (Ni)	mg/ l	0.2	0.5
Selenium (Se)	mg/l	0.5	1.0
Silver (Ag)	mg/l	0.1	0.1
Tin (Sn)	mg/l	2.0	2.0
Vanadium (V)	mg/l	1.0	1.0
Zinc (Zn)	mg/l	1.0	1.0
Ammonio + Ammonium (NH_3 + NH_4^+)	mg/l	10	No limit
Chloride (Cl)	mg/l	800	800
Free chlorine (Cl)	mg/l	1.0	5.0
Nitrate (NO_3)	mg/ 1	50	1.80

Note: *Limits for discharges via municipal facilities have been deliberately left out for the time being. Such limits would have otherwise been higher than those which are being proposed. This being the case, the burden of ensuring minimum pollution acceptable to the Tanzanian water bodies should be shouldered by polluters through complying with the proposed limits.*

3.2 Air Standards

Tanzania is not an industrialized country. As such the country may not be suffering from heavy loads of air pollution as is the case with other industrialized countries; however, all care should be taken to ensure that the country does not suffer the consequences of repeating mistakes of some industrialized countries.

Though it may generally be said that the air around us is on average good, this is only a general statement for the country. There are specific locations which are relatively polluted due to a numbers of reasons. Among these is vehicular emissions due to increasing number of cars (many of them old) in the urban areas, particularly in Dar es Salaam.

Also some areas having certain factories like those producing cement, (Dar es Salaam, Tanga, Mbeya), fertilisers (Tanga currently not under production), firms handling/fuel, hydrocarbon, (Dar es Salaam - With TAZAMA as a recent case, among others, are potential threats to the quality of air.

Much of the emphasis in Tanzania regarding air quality is the preventive approach; in the sense that potential developers will be bound to comply with the limits which are being proposed. For this reason, limits set for some parameters are relatively more stringent as compared to those of the more industrialized countries. In some countries, allowable values are set in phases, that is, grace-periods are set for given limits but eventually, these limits are to be changed to stiffer conditions because those which are currently in place are known to be unsafe or inadequate.

For Tanzania, these phases could easily be avoided without suffering significant economic repercussions.

Given the nature of the factories in Tanzania, a few parameters were selected on a priority basis, because of the limitation of resources and monitoring requirements . For each parameter, two limits are given: one for the ambient air and the other for emission. It is much easier to control the latter compared to the former.

It should be noted that an emission limit is a limit value for the concentration of any given substance in the emitted into the air (the emission concentration) that must not be exceeded. The limit is applicable for each chimney outlet, and is normally given in mg/norm m^3 or, in other words, as the total emission of pollutants during a set period of time where a plant is operational, divided by the number of cubic meters of emitted gas, converted to the reference condition ($0^{\circ}C$101.3. KPA, dry gas) for the same period.

3.3 Soil Standards

Polluted waters and air will in many cases unload the pollutant onto the soil . The land is also affected through anthropogenic activities. If the land is not polluted through emissions from industrial processes, which are eventually precipitated onto the land, then the later may be polluted through activities such as mining, agriculture, solid waste and liquid waste disposal.

A variety of chemicals, both organic and inorganic compounds, contaminate the soil in varying degrees. Mining and smelting processes and fuel combustion have given rise to contaminated soils containing a variety of heavy metals. Oil and tar residues from gas and oil refineries can contaminate the soils. Land-fill sites have increased methane concentrations in the air environment.

Direct application of fertilisers, pesticides and contaminated sewage sludges or irrigation water have contaminated many soils by altering the microbial activities and emission of green-house gases like nitrogen dioxide, nitrous oxide, among other, into the atmosphere.

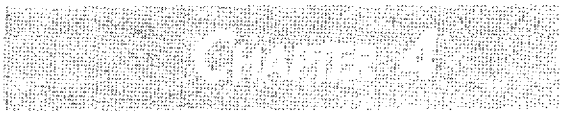
Tanzania has had standardised test methods for soil for quite some time, developed by the Mlingano Research Centre -Soil Central Laboratory (Tanga), one of the oldest research centres in the country. The methods used by the Soil Central Laboratory were aimed at adapting internationally accepted procedures. The standards being proposed form only a part of the said procedures and are being adopted from the International Organisation for Standardisation. For the time being, the standards being proposed are test methods.

3.4 Institutional Linkages

In Tanzania, the National Environment Management Council (NEMC), and Tanzania Bureau of Standards (TBS), jointly proposed an Environmental Management Divisional Standards Committee (EMDC), whose task is to approve standards related to managing the environment. This is a provisional body proposed in 1996, which includes various ministries, research institutions, universities, a cross-section of industries and some nongovernmental organisations. A Committee has been proposed to work under the chairmanship NEMC and TBS as the Secretariat. It has the responsibility of forming various technical committees to deal with specific areas of environmental standardisation. So far, it has formed two such committee, one on waste-water, and one on air. The technical committees can in turn form working group; however, working groups are disbanded once a specific task is

accomplished. The full list of the proposed EMDC is as shown below.

- National Environment Management Council
- Tanzania Bureau of Standards
- Ministry of Industry and Trade
- Ministry of Water
- Ministry of Health
- Ministry of Agriculture
- Ministry of Energy and Minerals
- Division of Environment (VP Office)
- Tanzania Breweries Limited
- Southern Paper Mills
- Centre for Cleaner Productions
- Tanzania Saruji Corporation
- University of Dar es Salaam/UCLAS
- Ministry of Transport
- Tanzania Italy Petroleum Refinery
- Tropical Pesticides Research Institute
- Journalist Environmental Association of Tanzania
- Centre for Energy, Environment, Science and Technology
- Tanzania Chamber of Commerce, Industries and Agriculture
- Association of Local Authorities in Tanzania
- Urafiki Textiles
- Tanzania Leather Associated Industries
- Sokoine University of Agriculture



4.0 CLASSIFICATION AND PRIORITISATION OF ENVIRONMENTAL STANDARDS

4.1 Water

4.1.1 Waste-water Standards

Standards are a management tool. One aspect of good management is to focus efforts and interests exclusively on actions necessary to achieve specific objectives. Where necessary, it is better to work in phases which are achievable rather than working on over-ambitious programmes which will eventually fail. For this reason, a few parameters have been selected for inclusion in the waste-water standards. In the course of monitoring and implementation, it is envisaged that the experience so gained, will help in the review of such parameters, and at the same time add more to the list. The list and reasons for choosing the parameters are shown below:

(i) pH

(ii) Total suspended solids (TSS)

(iii) Biochemical oxygen demand (BOD)

iv) Chemical oxygen demand (COD)

(v) Kjeldahl nitrogen

(v) Total phosphorus

(vi) Heavy metals, include: lead, mercury, cadmium, arsenic, nickel, copper, cobalt, aluminium, zinc, barium.

Reasons for Selecting there Parameters:

(i) pH

The pH, is a term used universally to express the intensity of acid or alkaline condition of a solution. In waste-water, pH has a special significance in the sense that, it must be controlled within a range favourable to particular organisms involved. Furthermore, chemical processes for coagulation of waste-water, precipitation of heavy metals, draining of the settled sludge and oxidation of certain toxins ions, for example, cyanide from waste-water require pH to be controlled within rather narrow limits.

The pH of fresh domestic sewage is slightly more than that of the water supply for use by the community; however, the onset of septic conditions may lower the pH further. Industrial waste-water may have extreme fluctuations in pH levels depending upon the nature of the manufacturing processes, raw materials and chemicals involved. For these reasons and because of the fundamental relationship that exist between levels of pH (acidity and alkalinity), it is important to include this parameter in the standard for effluents.

(ii) Total suspended solids

Solids found in effluents may be classified as suspended, dissolved, colloidal or settleable. Furthermore, these may be sub-divided into volatile and non-volatile fraction. Each of the above components have relevance in the general characterisation of waste-water.

It has been observed that out of 0.45kg total solids that may be present in Im^3 of domestic waste-water, approximately 0. 0225kg are in solution, 0.0 1 12kg in suspension and the rest are settleable.

The amount of suspended solids can determine the need for, and design of primary sealing-tanks in plants employing biological treatment processes. In the long-run, all suspended solids are considered to be settleable solids, when time is not a limiting factor. Hence, the need for limited allowable solids in effluents is of great importance. If left unchecked, suspended solids will eventually render treatment plants ineffective and other water bodies receiving the same filled with unwanted solids/sludge will increase levels of pollution.

(iii) Biochemical oxygen demand (BOD)

This test involves the measurement of oxygen consumed by living organisms (mainly bacteria) utilising organic matter present in the waste, under conditions as similar as possible to those that occur in nature.

Since a quantitative relationship exists between the amount of oxygen required to convert a definite amount of organic compound to carbon dioxide and water, the amount of oxygen required thus, can serve as a measure of biodegradable organic carbon. Theoretically, a very long time is required for the biological oxidation of organic matter to complete. It has been observed that a reasonably large percentage of BOD is exerted in 5 days, consequently the test carried out on a 5 day incubation period at 20°C is more or less, a median value, as far as natural water bodies are concerned.

When assuming aerobic conditions, the test is very useful in determining the strength of domestic and industrial waste-water pollutants, in terms of oxygen that will be required when discharged in natural water courses. The test is also greatly useful in assessing the performance of municipal and/or industrial wastewater treatment plants.

(v) Chemical oxygen demand (COD)

Chemical oxygen demand is also a term which indicates the strength of polluting water, in measuring the amount of oxygen which will be required, like BOD, for oxidising the organic matter. But, unlike BOD, the process is not limited to the biological activities (bacteria) only. This test does not differentiate between biologically oxidisable and non-oxidisable materials. The ratio of COD to BOD, however, does not change significantly for any particular waste.

The major advantage of the test is the short time required for evaluation. The determination of COD can be made in about 3 hours rather than 5 days as required for measurement of BOD.

For this reason, sometimes it can also be used as a substitute for the BOD test especially when the basic characteristics of waste do not fluctuate a great deal.

The variation in COD to BOD ratio of waste-water from an industry, may indicate change of raw materials or chemicals used in manufacturing processes.

(vi) Kjeldahl Nitrogen (N)

The faeces of animals contain appreciable amounts of unassimilated proteins. These are converted in large amounts to ammonia by the action of saprophytic bacteria under aerobic or anaerobic reactions. The ammonia released by the bacterial action may be used by plants directly to produce plant proteins.

All biological treatment processes employed by environmental engineers are dependent upon reproduction of organisms involved in the treatment process. In planning waste treatment facilities it becomes important to know whether the waste contains sufficient nitrogen for the organism. If not, any deficiency must be supplied from an outside source. The outstrophic conversion of ammonia to nitrates requires oxygen, and so discharge of excess organic nitrogen and its subsequent oxidation can seriously deplete the oxygen levels in rivers. Thus, measurement of organic nitrogen available in wastewater is of considerable environmental significance.

The *Kjeldhal* method employing sulphuric acid as the oxidising agent is a standard method of measurement of organic nitrogen in a waste-water samples.

(vii) Total phosphorus (P)

Phosphorus is known to be vital factor in life processes. The growth of algae in water is influenced greatly by the amount of phosphorus present. When nitrogen and phosphorus are plentiful, algae blooms may occur, which may produce a variety of nuisance conditions. The organisms involved in biological processes of waste-water treatment require phosphorus for reproduction and synthesis of new cell tissues.

Many industrial effluents, however, may not contain sufficient quantities of phosphorus for optimum reactions in the biological treatment unit. In such cases, inorganic phosphorus has to be added from an outside source in order to meet the requirements of the biological process at optimum level.

Thus, phosphorus determination are extremely important

in assessing the potential biological productivity of surface water; while on the other hand, limits are required in many areas so as to avoid unwanted growth of certain biological species like algae blooms in lakes and other reservoirs.

(viii) Heavy Metals

Originally, the phrase 'heavy metals' was used to mean metals with atomic weight higher than that of iron. The trend now is that 'heavy metals' is used in a wider sense to mean 'poisonous metals'. Some of these 'heavy metals,' like arsenic are not actually metals but are accepted in the same group.

The activities of mankind have resulted in an increase in the concentration of heavy metals in much of the environment, to a level where harmful effects on humans or the environment can be registered or anticipated.

Since heavy metals are elements, they cannot, in principle, be degraded and removed from our environment. The accumulation of heavy metals in the environment can only be halted by preventive efforts based on the concept of use cleaner technology.

Each heavy metal has its characteristics and related harmful effects. Those considered to be potentially more dangerous have been documented. Again, this is because the limiting factors are resources which include: equipment, personnel and finance needed when enforce standards. Below is the brief explanation of each heavy metal proposed to be included in the standard:

(a) Lead:

In Tanzania, lead and its products are widely used. Leaded tins, pipes, lead acid batteries, alloys and paints are just but a few products which contain lead. Leaded gasoline is also widely used in this country. Lead is rated among the most dangerous heavy metal.

In human beings, lead is known to cause for mental retardation. It is mainly concentrated in the bones. Lead presence in the form of lead ions, Pb^{++}, in the body, interferes with the action of chemical compounds necessary for production of haemoglobin.

Lead is also known to cause both acute and chronic toxic effects on plants, animals and micro - organisms.

(b) Mercury:

The metal flows at room temperature and is used in some chemical industries. In Tanzania it is also extensively used by artisanal gold miners, especially in areas around Lake Victoria.

Although the damaging action of mercury in the body is not fully understood, it is clear that all mercury compounds are poisonous.

(c) zinc:

This metal is one of the essential micro-nutrients, particularly for tropical crops. When present at relatively high concentrations, however, especially resulting from leaching processes, many harmful effects occur and thus, have been recorded.

Zinc is widely used in a number of ways. It is found in many agricultural chemicals such as pesticides and is a common impurity in fertilisers. It is also widely used in the electrical and electronics industry, in the making of semi-conductors, batteries, among others. Other uses include polymer stabilisation, and the making of pigments and paints.

This metal mainly enhances phytotoxicity, and has relatively low toxicity to animals and human beings. Most zinc sources/mines are associated with cadmium as a guest element, hence whenever zinc is detected, it is reasonable to suspect the presence of the more toxic metal such as cadmium.

(d) Aluminum:

Aluminum is not a heavy metal. Nevertheless, for the purposes of considering its toxicity, is placed under this same group.

When compared to other heavy metals, aluminum doses do not pose as a big danger. In fact, some of its salts are extensively used in the treatment of water.

Aluminum is widely used as an alternative to steel for dadding structures, and as an alternative to copper in electricity conduction. Aluminum-oxide (alumina) is extensively used in industry as an abrasive.

Aluminum acetate is regarded as weak sensitizer, but may cause dermatitis on contact with the side. It is also regarded as a mild irritant. Patients under-going

kidney dialysis could develop dementia as a result of the accumulation of aluminum in water" Some investigation on the brains of human beings who had died from *Alzheimer's* disease (senile dementia) revealed high concentrations of aluminum.

(e) Cobalt:

Cobalt has a wide range of uses, especially in the making of various alloys.

Cobalt salts produce polycythemia in animals while in humans it causes liver and kidney damage. Cobalt has also been shown to produce dermatitis and some investigators have been able to demonstrate hypersensitivity of the side due to cobalt. There have also been reports of hematologic, digestive, and pulmunary changes in humans. The metal is a suspected carcinogen of the connective tissue and lungs.

(f) Barium:

The soluble salts of barium, such as the chlorides and the sulphides, are poisonous when taken orally.

Barium benzoate is a deadly poison, while barium phosilicate is used as an insecticide.

In natural waters and least polluted areas, barium is normally detected in the ranges of mg/l (parts per billion).

4.1.2 Limits in Drinking Water

As already stated, the aim of putting limits is to protect different waters for the intended uses,

be it for irrigation, sports, among others. Special attention, however, is always given to water used for drinking purposes. The limits discussed in the previous section on waste-water, are normally set against this background; that is waste-water may eventually be treated, diluted and finally find its way to drinking water sources.

The limits set for water intended for drinking purposes are more stringent for obvious reasons. The Tanzanian Bureau of standards has just finalised preparing a national standard for requirements in drinking water. The standard, TZS 574: 1997 is expected to be published soon.

4.2 Air Quality Standards

As is the case with waste-water standards, a priority list of baseline parameters had to be selected based on a number of factors. Among these factors include toxicity, nature of industries in Tanzania, and monitoring requirements. The proposed parameter for documentation include the following:

(a) Sulphur dioxide:

When this gas is released into the atmosphere, it is converted into acid compounds that destroy forests, acidify lakes and rivers, corrode materials and cause ailments in human beings.

(b) Dust (inert):

This may have adverse effects on health depending on the size. In relation to effect on health, related dust particles is of interest here, in most cases, is the size of 10 microns which is regarded as the margin.

Dust, however, may also be a nuisance to the environment apart from the health related problems.

Active dust is a issue which may be tackled on a case/type basis. Active dust was therefore, not dealt with in this report.

(c) Hydrocarbons/Greenhouse gases

Hydrocarbons like methane, together with other green-house gases (GHG), like the oxides of carbon, sulphur, nitrogen, among others, cause global warming as a result of increased GHG emissions. Since hydrocarbons are a result of so varied activities, especially from the petroleum industry, limits are given to minimise the overall discharge from various emissions. Due to the varied composition of many products from the petroleum industry and other hydrocarbons, a more convenient method of their determination is to limit the Total Organic Carbon (TOC).

(d) Carbon monoxide

This gas has the ability of combining with haemoglobin, thus, rendering such haemoglobin useless since it can no longer take oxygen which is required by the body for metabolism. As such, limits have been proposed. The limits, however, have been classified, so that liquid fuel combustion engines have more stringent limit because of their nature and usage.

Plants using solid fuel combustion with beat output of 50 Mega Watts and above have been greatly affected according to the standard being proposed.

4.3 Soil Standards

Unlike water and air which circulate easily, the soil of a particular locality can hardly be influenced by other soils - except to a United sense by the movement of soil water. As such, general limits which could be declared as standards for Tanzania soils have to be very carefully considered. Mapping, and a lot of data, is required for this purpose. Such general limits, however, may not make sense if they have been exceeded in particular localities.

For the time being efforts have been made towards categorisation of various soil types. Such information should be very useful in decision-making processes on what to do with different soils types.

Test methods are extremely important in classification of soils. In T a, particularly in the Mlingano Research Centre in Tanga region, such test methods have been developed for quite a long time. Their latest manual has over 40 methods for testing about 20 parameters of soil. The analytical methods developed by the Centre follow closely internationally accepted procedures. Many of these standards are used by other soil research centres, including the Sokoine University of Agriculture.

After studying the various test methods in the country, The test methods adopted from the International Organisation of Standardisation (ISO), have been proposed to begin with. These include:

(i) Guidance on the collection, handling and storage of soil for the assessment of aerobic microbial processes in the laboratory.

(ii) Pre-treatment of samples for physico - chemical analyses.

(iii) Determination of pH.

(iv) Determination of organic and total carbon after dry combustion.

(v) Determination of carbonate content.

(vi) Determination of specific electrical conductivity in soil.

(vii) Determination of sulphates in soil.

In order to standardise communication on soil matters, a national standard on terms used in soil (vocabulary) have also been proposed.

CHAPTER 5

5.0 INSTITUTIONAL MECHANISMS FOR IMPLEMENTING ENVIRONMENTAL STANDARDS IN TANZANIA: HUMAN AND TECHNICAL RESOURCES REQUIREMENTS

As noted earlier, environmental management in Tanzania is carried by a myriad of institutions which tends to defeat the entire objective to conserve the environment. Currently, there is no integrated system to enforce standards and issue licences to polluting facilities. Untreated effluent is being discharged into certain areas of the environment because of lack of a comprehensive regulatory framework. One of the critical regulatory tools against owners/agents of polluting facilities is licensing which if used appropriately can ensure that facilities do incorporate feasible environmental safeguards against pollution in their establishments.

5.1 Institutionalising Licensing of Polluting Sources

Due to the prevailing environmental problems and a confused institutional set-up for environmental management in Tanzania, there is need to have an integrated licensing mechanism to require a facility seeking to discharge pollutants in excess of the existing standards on air, water , soil, among others, to apply to NEMC for a pollution licence.

Studies carried out by NEMC on some selected industries (for example, textile, foods and beverages, pesticides, tanneries, sisal) located in Tanga, Morogoro, Mwanza and Dar es salaam, to determine effluent characteristics and condition of effluent treatment plans, have indicated that the water legislation and standards were being violated. Some of the contributing factors to this scenario included the following:

(a) adequate attention is not given to prevention of industrial waste. Most of the facilities discharge untreated effluent into natural systems;

(b) the existing treatment plants, mainly stabilisation ponds are non-operational;

(c) most of the industries were experiencing both financial and the requisite technical constraints; and,

(d) there is lack of effluent monitoring mechanism to check and evaluate the quality of the effluent at the plants. A monitoring mechanism is necessary and should have adequate qualified staff, finance, equipment and powers to enforce laws in order to implement the existing water standards. (See *Materu (1995)*

Given this scenario, NEMC Act has to be amended to require persons seeking to pollute the environment contrary to environmental management guidelines, to apply for a license. Section 4 0) requires NEMC to advise the Government by, *inter alia,* formulating proposals for legislation in the area of environmental issues and recommend their implementation by the Government.

Such areas include: management of lakes, rivers, wetlands, preservation of biodiversity, elimination of ozone depleting substances and land use planning.

Once the provision for licensing is entrenched into the NEMC Act and a Technical Committee on Licensing Polluting Sources has been established. The Committee may receive licence applications and review and approve or reject the same. The persons who may be affected by the proposed activity must be given an opportunity to comment on the application. While considering the application, the

Committee must get comments from the public as well as from the government officials. If deems it fit, the Committee may require the applicant to perform an environmental impact assessment.

The issuance or renewal of a licence must be accompanied with a fee to be charged in accordance with the "polluter pays principle". Although the fee structure should be tailored in such a way that it discourages polluting activities, collecting the fees to cover the cost brought about by pollution, may not be as efficient as requiring companies to use technology that will prevent pollution before it occurs. In addition, the renewal of license should be based on the previous record of the applicant if such an applicant has complied with license conditions, whether it has taken measures to comply with standards and abated pollution; and, the records of extent of pollution caused by the applicant.

The Committee should also be given powers to cancel a licence once it is satisfied that the licensee has breached the terms and conditions set in the licence; or if it sees it in the interest of protecting the environment to do so. Provided that the licensee will be afforded an opportunity to be heard in accordance with the principles of natural justice.

5.2 The Need to have an Integrated to Approach to Licensing

Currently there is no system for monitoring and licensing polluting sources in Tanzania. The practice has been the issuing of pollution licenses targeted at one environmental media, in such a way that, a facility discharging waste-water and emitting air pollutants, is required to obtain one license for waste-water discharges and another for air pollutants. This sectoral approach to licensing fails to consider the inter-related nature of a facility's operations and therefore, increases the likelihood that reduction of emissions in one media will translate into increased emission in another. For instance-, a reduction in waste-water discharges may lead into those same wastes being degenerated into solid form.

An integrated approach to licensing examines the facility's operations as a whole, considers the entire process and thus, enables the facility and the regulator to assess the trend of the discharges from one media to another, and prevent the possibility that environmental gains in one media will result in losses in another. *(UNEP, 1992)*

A holistic approach to licensing takes into consideration the facility's entire operations, whereas the single media approach limits itself to the end-of-pipe measures as a means to reducing emissions. The single media licensing approach also complicates the institutional mechanism for enforcing compliance with pre-set standards, because one institution will be regulating air emissions requirements while another inspects it to ensure compliance with waste-water discharge limits.

Indeed, integrated approach to licensing would require the facility owners or operators to supply all information in respect of potential environmental consequences which may arise from their activities. The permit would reflect all the facilities discharges, including waste-water discharges, solid waste and air emissions. In this way, NEMC will be able to regulate even those emissions for which it has not developed standards. For instance, if an application for a permit to discharge waste-water above the threshold of the established standards has been submitted, then the Technical Committee could limit the facility's air emissions through the licensing process, even though the air quality standards are not in existence. The Technical Committee on licensing, may also encourage applying owners or operators to consider low-cost protective and mitigation measures such as installing automatic shut-off valves on hoses, recycling scrap materials, among others.

In order to eliminate duplication and inefficiency in inspection and enforcement efforts, it is indispensable that the government should adopt an integrated approach to licensing. Incorporating all affected environmental media in one permit will, enable NEMC to co-ordinate the enforcement efforts among sector ministries and in order to conserve resources NEMC will need to prioritise polluters targeting first on the most polluting ones.

5.3 Human and Technical Resources Requirements of the Technical Committee on Licensing of Pollution

The Technical Committee on Licensing is a critical organ which will be mandated to issue or reject to issue pollution licenses. The presence of qualified staff in the Committee is important so as to ensure the success of the licensing process. The composition of the Committee will depend on the nature of the application or activity in question; but there have to be some permanent staff on the Committee to work as the "the secretariat." The Secretariat would conduct preliminary enquiries on the application and consult with experts on the issues in question.

The Secretariat should include an environmental economist who will calculate the licence fee in accordance with the "polluter pays principle". For pollution licences meant for industries, the Committee should have one member from

the Tanzania Confederation of Industries (TCI) or the Tanzania Chamber of Commerce, Industries and Agriculture (TCCIA), in order to have a balance in the Committee's decisions. Others may be from the Government Chemist, the University of Dar es Salaam, among other institutions.

In general, the Committee should be composed of a multi-disciplinary team of experts on different fields including experts on pollution of various media , so as to facilitate an integrated approach to licensing. A lawyer to the Committee should strive to appraise the Committee on various legal requirements with respect to pollution. It is also recommended that a representative from the Tanzania Bureau of Standards (TBS) should be in the Secretariat in order that environmental standards are complied with, or in the event of that their are overlooked, the concerned party bears consequences of the impact.

Such a person (TBS) will be in a position to recommend temporary standards for any pollutant for which standards have not been developed.

5.4 Capacity Building for Implementing of Environmental Standards

Tanzania has got a number of qualified staff in the fields of natural resources management, Chemistry, Biology, engineering, among others; however, staff in the environmental field are not properly empowered and their mandates are unclear. There is need therefore, for the Government to enable monitors to assess whether compliance to the rules, codes of practice have been observed. Monitors will therefore need to be exposed to a range of new skills pursuant to changes in technology.

Specific skill and training of staff in the field of environment is indispensable in view of the frequent changes in environmental dynamics. As such, training programmes should comprise the following:

- monitoring compliance with environmental standards;
- screening and scoping consultations;
- review of environmental statements;
- setting conditions on licences;
- investigation of pollution incidents; and,
- and preparation and prosecution of offences.

To carry out those tasks, professionals in these fields will be needed, and these include:

- environmental engineering;
- environmental chemistry;
- environmental law;
- laboratory analytical services;
- ecology;
- landscape and use architecture and sciences; and
- socio-economics

There is also need to equip the existing national laboratories, for example, the Government Chemist Laboratory, University of Dar es Salaam , Tanzania Bureau of Standards, with appropriate equipment and technology.

5.5 Categorising Facilities with Environmental Risks

A system should be established in which a regulatory agency issues a regulation which requires a particular category of facilities whose environmental risks are understood; and relatively small to enable compliance with some conditions which are similar to those contained in the individual permits, such as discharge standards, operational guidelines, and self-monitoring requirements. A facility covered by the regulation will be deemed to have been licensed and will not need to undergo a formal application and review process, *(ELI, 1999)*. In this way the regulatory agency is relieved of the burden and costs of operating the licensing system, but can enforce judicial proceedings against facilities that have not complied with the applicable conditions.

Invariably, a similar methodology may be adopted to empower the regulatory body to deny permits for a class of regulated activities.

For instance, activities such as hazardous waste disposal may not be permitted in ecologically fragile areas, for example, wetlands and localities with high-water tables. This regulatory approach takes into account the precautionary principle and averts the costs of having the regulatory agency delve into complicated scientific calculations, or the possible impact of the activity on the environment likely to occur in each permit application.

5.6 Proposed Contents of the Licence Application

The NEMC Act may only stipulate the generic contents that may be in a pollution license. The detailed contents, however, may be covered by regulations. The application should contain details of environmental profile of the applicant's facility including: the surroundings, manufacturing process, pollution prevention, mitigation measures, among other aspects. A model can be seen in the UNEP Manual on Industry and Environment (UNEP Office/UNIDO): *Audit and Reduction Manual for Industrial Emissions and Wastes, (1991).* The manual contains examples of how to carry out a material balance indicating material and energy inputs and outputs in flow chart form, including emission to the environment.

Undoubtedly, if the applicants facility exceeds the established standards, the regulatory agency should require the applicant to submit comprehensive information on measures to be taken in order to ensure compliance with applicable requirements; and the time frame for such compliance should also be provided.

It is recommended that the compliance plan be proposed by the applicant, rather than the regulatory authority, because the applicant would known industrial processes and discharge systems better than anybody else. In addition, if the applicant certifies a certain method and schedule of compliance that it can achieve, and yet does not abide by it, then enforcement mechanism can be initiated. ***(ELI, 1993)***

Interim measures and deadlines to fulfil the compliance plan should be included in the plan and be monitored. The interim measures enable the facility to take some steps before the time allotted for compliance has expired. The application should also provide for an emergence preparedness plan and methods of dealing with anticipated emissions levels. Waste treatment and disposal methods should also be described.

Monitoring and reporting mechanisms should also be spelt out in the application, once EIA is a legal requirement, new applications for a licence will have to incorporate their EIA reports with their applications. EIA will contain mitigation measures and options to reduce possible impacts on the environment and thus, need not be duplicated in the licence application.

The license should also spell out what breach of any term or condition in it, is an offence.

5.7 Applying the Polluter Pays Principle While Enforcing the Standards

The Draft National Environment Policy stipulates under Paragraph 76 that:

> *"As far as possible the preventive approach to the environmental problem shall be given top priority. Liability for environmental pollution shall not be passed on. The polluter-pays principle shall* be *adopted and implemented deterrently. In principle it shall be the responsibility of those who pollute to repair and bear the costs of pollution caused and rehabilitation, where appropriate."*

It is in such a spirit depicted in the policy, that it is applicants requiring pollution licences must pay fees in accordance with the polluter pays principle upon issuance or renewal of a licence. The fees to be collected should provide a revenue base to the regulatory authority. The setting of the fees, however, should strike a balance between providing financial incentives to induce polluters to install pollution control technologies, or make it a means of generating revenues which will ultimately be used for environmental management. -

Indeed, the fees should not be prohibitively high, so that illegally discharge wastes is not encouraged. Fees may be set in accordance with the amount and the concentration of pollutants. Alternatively, large polluters may pay according to the volume of their pollution while small polluters pay fixed fees. Examples from developed countries indicate that effluent fees have prompted industry to recover about 40 percent of the industrial acids used in production *(Lee, J, 1985).* As such, industries may be induced by effluent fees to reduce emissions even though they might be lower than the marginal cost of investing in pollution control technology. These examples may serve as a good model to NEMC when developing guidelines for the assessment of licence fees.

5.8 Monitoring and Enforcement of Licenses to Pollute

Licenses are not self-executory, they need an effective enforcement mechanism to ensure that the stipulated terms and conditions of the licence are being implemented. In addition, the enforcement programme should ensure that whoever violates these terms and conditions does not make profit out of it; and society has to be compensated for the damages it has endured as a result of the violation of set terms and conditions.

In order to have an effective monitoring and enforcement mechanism, the NEMC Act should be amended to require mandatory record-keeping and reporting of emission activities. Then each facility's license should provide for enforcement mechanisms in order to reduce or mitigate the onus of detecting and proving the violations. For example, a facility will be required to periodically monitor its emissions pursuant to the agreed measuring methodology and record emissions data accordingly in the facility's emission chart. The emissions records are then to be submitted to the regulatory Authority (or NEMC) which shall make the information available to the public. The Authority should consider violation of the license conditions, and take offence of any failure to monitor emissions or submit reports to it.

To expedite the reporting system, NEMC should design reporting forms basing on the categories of polluting facilities, and require the violators to submit a separate notice of violation. The report if in excess of the laid down standards, is *ipso facto,* an admission of violation and no separate notice of violation will be needed. In such away NEMC will save a lot of resources in enforcing the licences.

The NEMC Act does not have a provision on environmental inspection. In order, in order to have an effective enforcement programme, however, the law must provide for powers of the regulatory authority to inspect facilities to ensure that they are adequately monitoring their emissions, accurately reporting their results, and adequately complying with other permit requirements. Despite this *lacunae* in the law, the licenses may provide for a general consent to inspect so as to enable the enforcing authority to have an unimpeded access to the facility.

It is also important for the NEMC Act and the license to provide for the penalties for non-compliance of the licence's terms and conditions which may include: the suspension of the facility's permit and closure of its operations; imposing civil or criminal penalties; and, ordering that the facility complies with certain pollution control measures within a specified period of time. Every facility license should incorporate these enforcement measures. The Authority, however, should be given the mandate to give a grace period to a facility that will guarantee compliance or investment in pollution control equipment.

6.0 PROPOSED OPTIONS FOR ENFORCEMENT OF ENVIRONMENTAL STANDARDS WITHIN AND ACROSS NATIONAL BORDERS

The physical conditions of the three East African states are more or less the same and thus, warrant a common approach to solutions of the common environmental problems. Given this factual situation, the three states may wish to develop identical regional standards which may be enforced across the geographical boundaries. Compliance with environmental requirements, however, is a process which entails a variety of strategies and the capacity to innovate new strategies in the event of failure of the existing ones. This chapter is concerned with the process by which the objectives of the regulations, procedures and standards due to be enacted, are being implemented and translated into reality at the national and regional level.

6.1 Financial Incentives and Tools

East African countries like many other third world countries, are moving towards a fully-fledged market economy. The role of the private sector in the economy has also been immensely augmented, whereas on the other hand, the government retains the regulatory role. Undoubtedly, the shift from a centralized economy to a market economy will entail the governments, as regulators, to use regulations while at the same time employ economic instruments to counter the effects of the inter-play of market forces and the environment. The application of appropriate economic instruments for environmental conservation by governments has proven elsewhere to be more effective than the use of orthodox command and control regulation ***(ELI, 1993)***. Advantages of using market based approaches for environmental conservation include:

(a) their potential for attaining a specified level of environmental protection at a minimum cost; and,

(b) their ability to directly involve key players in the market circle, namely, the producer and the consumer, by making the two pay directly for environmental damages emanating from the production process and consumption of goods and services.

The effectiveness of market approach, however, is dependent on the strength of the regulatory framework. A number of economic instruments may be suggested but the conventional ones include the following:

(a) Agreements between regulatory authority and industry committing the latter to abide and clean up effluents they have discharged at their own cost.

(b) Use of licences and permits and financial incentives to develop and use cleaner technologies.

(c) Introduction of green-taxes which aim at gauging the use of natural resources, and reflect the value of the environment.

As it is in Uganda, the other East African states could amend their environmental laws, to empower the Minister of Finance to include environmental tax incentives and user fees in the annual budget. Environmental institutions, however, should regularly investigate the existing subsidies and taxes and identify those which encourage destruction of the environment. Instances of tax incentives and reaction which have led to destruction of the environment include: deduction of taxes on fertilisers and pesticides, which

sometimes reduces soil fertility, cause skin cancer and related diseases, and increased pollution. Such tax subsidies once identified should be replaced by the more sustainable ones.

6.2 Stream-lining the Judicial Process

In order to save the resources of law enforcers and also to extend their horizons, it is proposed that environmental regulations be amended to contain public interest provisions. Environmental institutions cannot and will not on their own be able to uncover every case of non-compliance, and will need to prioritise cases that they wish to institute. As such private enforcement will fill the gap left by environmental institutions and assure the citizenry of legal remedies to environmental violations.

Furthermore, since most environmental institutions are working on behalf of the government or managed by government appointees, it may sometimes be unwilling to take action against a government body or a politically sensitive project. Private prosecution will serve as a check on the statutory responsibilities of these institutions - their acts and/or omissions. In the absence of this watch-dog role of the public, however, environmental institutions will exercise unfettered discretion, will be docile in front of politicians and susceptible to corruption, and will lose public confidence.

6.3 Civil and Criminal Penalties

In Tanzania there has often been an out-cry that environmental laws prescribe very low penalties which either makes violators of the law gain economically or they not deterred by those penalties. Thus, the environmental statutes should provide for both criminal and civil penalties in order to deter violators. In other words, the penalties must be sufficiently punitive and the amount of the penalty should correspond with the duration and severity of the violation, and should also exceed the benefits accruing from non-compliance. In designing the penalties under environmental laws, the drafters should be careful in categorising offences that could lead into criminal liability and hence, punished by imprisonment or fine or both; and those that may be civil in nature punished by a fine and/or compensation. In addition, penalties may be stipulated in regulations so that environmental authorities may have a lee-way to amend them when whenever there is need be without going through the parliamentary bureaucracy.

In order to avoid fluctuation of the East African currencies fines may be fixed in dollars (as it is with the Exclusive Economic Zone Act in Tanzania) and also fines be recoverable as civil debt. It is also recommended that heavier sentences be imposed on multiple offenders and permit renewal and approval be based on good behaviour. A standard could be set for meting sentence, for example, a "wilful" violation could lead to both civil and criminal liability while a "negligent" violation may result only in fine. Criminal penalties should therefore, be left to more serious offences because experience has shown that criminal sanctions are more difficult to enforce because the offenders will devote more resources in litigation than those merely required to pay a fine.

6.4 Environmental Restoration Orders

Uganda has this enforcement provisions in its Environmental Statute. These provisions may also be introduced in the other countries. The purposes of the environmental restoration order may be four-fold:

(i) to prevent actions which are likely to harm the environment;

(ii) to require restoration of the environment;

(iii) to compensate persons adversely affected by an action; and,

(iv) to reimburse government or other parties who have undertaken restoration work.

Before issuing the order it will be the duty of environmental institutions to prove that no harm has been done, on the environment or is likely to be done on the environment by a person performing such act. Environmental institutions, however, will also have to establish a threshold level in which it may accept restoration of the environment to acceptable standards; and not necessarily to be exactly as it was in the former pristine state. Containing damage in a cost effective manner should be the target of the restoration order.

6.5 Performance Bond

By definition, an environmental performance bond is a deposit that likely polluters and violators of environmental standards must pay to a certain environmental fund. These bonds are aimed at providing financial incentive to industry to adhere to environmental requirements. In order for environmental institutions to efficiently administer the bonds the following must be done:

- registration of facilities and activities that have or are most likely to cause significant impacts on the

environment when operated or carried out in a manner that is not consistent with good environmental practice; the government (environmental institutions) should have the power to require facilities included in the register to post a bond as security for good environmental practice;

- further powers should be given to environmental institutions to confiscate a bond if it is satisfied that the operator of a registered facility has breached the provisions of an environmental statute; and,

- alternatively, environmental institutions may require a bond subject to EIA or licence requirements, and if the facility fails to comply with the EIA or licence requirements, then the bond may be confiscated.

For performance bonds to be effective, the law must be very clear on what kind of activities will constitute a breach of the environmental statute. The latter may contain a schedule prescribing the potential activities required to submit bonds, including any activity that requires an EIA or pollution licence.

6.6 Requirement to Keep Environmental Records

Record keeping is a tool which facilitates the work of environment inspectors. The statute should also require any person whose activity has or is likely to have significant impact on the environment, to keep detailed records of those activities , their effects on the environment, and the compliance with those activities stipulated in the statute. The records should be submitted to an environmental institution on an annual basis. Criteria may be developed to guide environmental institutions in determining which facilities should be required to submit records. The criteria may be similar to the ones applying to facilities required to issue a performance bond.

It should be an offence to fail to keep, or to fraudulently alter the records. Therefore, by enforcing the record keeping obligations under the statute, environmental institution will be able to augment its enforcement horizon, since these records will indicate whether such institutions whether a facility is violating any standard or provision of the statute. The key to the success of the record keeping system is to ensure that facilities do submit genuine records, and those which do not should be given deterrent penalties. Thus, record keeping obligations will need to be publicised for operators of facilities and the latter should know the repercussions of non-compliance.

6.7 Environmental Inspection

Environmental inspection is another tool of enforcing environmental standards. In order to give the environmental inspectors enough powers to enforce their mandate, environmental statutes should give them powers to seize property, close facilities, and order arrests, as it is the case in Uganda *(See Uganda National Environment Statute, 1994)*. In appointing inspectors, environmental authorities could also use the existing inspectors in other ministries, for example, inspectors, at the Factories Inspectorate and the Department of Occupational Health within the Ministry of Labour who have experience in inspecting facilities to assess compliance with the worker and health standards. In Tanzania, the personnel at the Dar es salaam Water and Sewerage Authority (DAWASA) and the Tanzania Bureau of Standards (TBS), may also be enlisted as National Environmental Management Council Inspectors.

In order to facilitate the inspection process, environmental institutions will need to prepare an inspection check-list and have properly trained inspectors who will be able to sample industrial effluents, detect violation of pollution licences, and identify activities likely to harm the environment. The inspectors, however, should judicially exercise their powers and should consult and issue adequate notice before inspection, seizure, closure or arrest.

Due to the limited resources available to environmental institutions in East Africa, these institutions could focus their initial inspection on large facilities most likely to cause environmental damage. Invariably, threat to inspection will trigger the facility's propensity to comply with environmental requirements and thus, reduce the work-load of these institutions in enforcing the standards.

6.8 Prosecution and Enforcement Actions

Most of the legislation on the environment in Tanzania, which may be the same in the other East African countries, are broad-based and issue punitive measures related to almost all kinds of pollution; while at the same time, do not provide for effective licensing or standard setting systems. In Tanzania, for example, there are no set environmental standards for soil and air, and existing water standards are only temporary. It is also worth mentioning that there is generally lack of confidence by the public to enforce environmental laws through the courts due to corruption, unnecessary delay, of cases and partiality of some members of the bench.

Normally, before meting out a criminal or civil penalty there must be a conviction. As such, environmental institutions will be required to prosecute any violation before a violator is required to pay a penalty. Litigation is a costly and unpredictable exercise and thus, a stream-lined procedure has to be adopted for these institutions to be able to utilise the judicial process effectively. In addition, environmental institutions should be given powers to compound offences.

6.9 Establishment of a Joint Committee on Standards for the East Africa Sub-Region

Pursuant to the close co-operation between East African States, there is dire need to have a joint institution be established on promulgation and enforcement of environmental standards. The Committee may be working under the aegis of the East African Commission. Such a Committee is important to ensure that environmental standards are implemented across national borders in a harmonised manner. The Committee will be responsible for liaising with environmental authorities in the three East African states and making proposals for environmental standards not only for shared resources (such as Lake Victoria), but also for water, air and soil generally.

SELECTED BIBLIOGRAPHY

Afloway, B.J: *Chemical Principles* of *Environmental Pollution (19..)*.

Environmental Law Institute (ELI): *Practical Approaches to Implementing Environmental Laws: Getting From Here to There* (1993).

Environmental Law Institute (ELI): *Information Access Mechanism: Collecting the Information Necessary for Environmental Protection* (June 1993).

Kamukala, G: *Institutional Structures for Environmental Management in Tanzania.* Paper Presented at National Environmental Legislation Workshop held in Dar es Salaam, September 4-6, 1995.

Lee, J: *The Environment, Public Health, and Human Ecology: Consideration for Economic Development (1985).*

Materu, L: *Water Pollution -Environmental Legislation Proposals.* Paper Presented at National Environmental Legislation Workshop held in Dar es Salaam, September 4-6, 1995.

Shauri, V: *Environmental Litigation In Tanzania: Prospects and Constraints. Paper* Presented at a UNEP/ UNDP Workshop on Environmental Litigation Held in Kampala, 18-23, August, 1997.

UNEP/IEPAC: *From Regulations to Industry Compliance: Building Institutional Capacities* (1992).

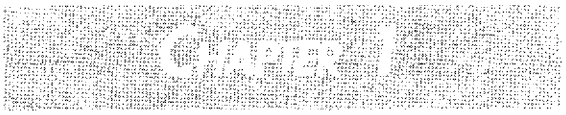
UNEP/UNIDO: Audit and Reduction Manual for Industrial Emissions and Wastes, (1991).

UGANDA COUNTRY REPORT

LIST OF ACRONYMS

ELU	Environment Liaison Unit
ILO	International Labour Organisation
KCC	Kampala City Council
LGC	Laboratory of the Government Chemist
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MOE	Ministry of Education
MUK	Makerere University, Kampala
NEAP	National Environmental Action Plan
NEMA	National Environment Management Authority
NGO	Non Governmental Organisation
SIDA, RSCU	Swedish International Development Agency, Regional Soil Conservation Unit
TVA	Tennessee Valley Authority
UNEP	United Nations Environmental Programme
UNDP	United Nations Development Programme
UEB	Uganda Electricity Board

LIST OF TABLES



1.0 INTRODUCTION

1.1 Background

The purpose of this work is to develop soil standards for Uganda. This is part of the on-going activities of NEMA to improve the environment. It is generally believed that the development and enforcement of soil quality standards is the most important requirement for the long term sustainability of the productive capacity on croplands, forest, wetlands and range ecosystems and overall environmental management.

Uganda enacted the National Environment Statute in 1995, to provide a framework for sustainable management of environment and consequently, established the National Environment Management Authority, (NEMA) to implement it. Section 31 of the Statute requires NEMA to develop soil quality standards and the criteria for monitoring the said standards.

Since the final preparation of this report, a draft Environmental Standards (minimum standards for

the Management of the Quality of Soil) Regulations, 1999 have been drafted and are attached to this report.

1.1.2 The Context

Earlier work (the NEAP Process) in Uganda identified the following as the major environmental problems:

- Land Degradation (especially Soil Erosion)
- Deforestation
- Loss of Biodiversity
- Degradation of Wetlands
- Pollution
- Unsanitary Conditions

It is evident from the above list of issues that soil degradation ranked high. The main causes of land degradation were also identified as:

- Land Fragmentation
- Inappropriate farming systems and methods
- Overgrazing
- Poor management of agrochemicals use
- Deforestation
- Bush-fires

In order to improve the soil quality, through the development of standards, this work will focus on the major problem, namely, soil degradation and make an effort to address it.

1.1.3 The Soils

The country is underlain by some of the world's oldest rocks which have been modified and altered by deep-seated tectonic activity. These rocks are overlain by predominantly ferralitic soils, and to a lesser extent ferruginous soils, which are the most widely distributed soil types, occurring in both forest and savanna ecosystems in the country. The profile of these soils consists of a thin (20-30 cm) top-soil and a deep (5-10 m) sub-soil. Organic matter and nutrients are strongly concentrated in the top-soil. These soils range in texture from clay loams to sandy loams. Red clay loams tend to predominate in wetter regions and are reportedly more fertile, while in the drier northern parts of the country,

sandier soils containing fewer nutrients are quite common. Hydromorphic, podsolic, high altitude and dark ferralitic soils are highly weathered and are thus acidic and deficient in plant nutrients. Where vertisols occur, they are characterised by water-logging and poor internal drainage. The holomorphic soil types are saline.

In general, the ferrisols and eutrophic soils are the more fertile and productive, while ferruginous ones are less productive and thus, require careful usage to preserve their poorly developed horizons. Ferrallitic soils are highly weathered and have very low mineral reserves and so depend largely on added bases for their fertility. The heavier textured soils tend to be more fertile because they are less prone to leaching than sandier textures.

Generally, the productivity of soils depends on favourable rainfall, adequate depth and maintenance of the humic top-soil. Due to the country's latitudinal location and climate, the soils are very prone to geological and accelerated erosion. **Figure 1.1** is the soils map of Uganda.

1.1.4 Topography

Figure 2 shown the topographic and drainage system of Uganda.

The main topographical features to the north of the country lie towards the eastern and north-eastern borders and include three large Miocene volcanoes, namely, Moroto (3,890 m), Kadam (3,070m), and Napak (2,540 m), and a number of hills, which are composed of Basement complex rocks. Similar plateau elevations are found in West Nile to the North-west of the country. Many of these volcanoes and mountains have been extensively scoured by erosion. Relative relief is low, seldom more than 20 - 30 metres.

South-ward from the northern plains, which range between 750 m and 1,110 m, the plateau level rises towards the Lake Victoria water-shed, through a narrow zone of flat-topped hills in the central and west-central parts of the country. In this zone, the relative relief is in the order of 150 metres. While similar land-forms are found in the off-shore islands of Ssese, Kome and Buvuma, the hill-tops are generally lower, but to the west of the Lake, the hill-top level rises.

In the Masaka area, the hill-top level stands at 1320 metres, whereas it rises in Koki to 1380 metres and in other parts of Rakai and Mubende to 1500 m. South in Bushenyi, the hill-tops show a continuous rise to over 1800 m. In the south-west of the country, in Kabale and Kisoro, the plateau reaches its greatest heights with hill summit levels at about 2100 metres.

As the plateau level rises to the east and west, it is emphasized by the impressive mountainous topography found along the international border. To the west lie the Mufumbiro volcanoes, the Rwenzoris and part of the deep trough of the Western Rift Valley. To the east, the Uganda-Kenya border is marked (to the south) by Mt. Elgon (4,320 m) and the stump or plug of Tororo Rock and a complex of similar eroded volcanic plugs. Relief contrasts are greatest in the west; from the high peaks of Rwenzori to the hot arid flats around lake Albert to the north, there is a height difference of nearly 4500 metres.

The highest point in the country, the summit of Mt. Stanley, rises to 5,040 metres above sea level, while the lowest part is in the far north-west on the Sudan border, close to Nimule, where the valley of the Albert Nile drops to about 600 metres above sea level.

1.1.5 Drainage

Most of the drainage system of the southern part of the country drains into Lake Victoria, from where the waters escape through the Owen Falls Dam into the Victoria Nile, Lake Kyoga and to Lake Albert. The Kagera and Katonga rivers all rise at present in the swamp filled gaps in the upwarped rift rim of western Uganda and flow sluggishly east to the Lake Victoria and are joined along the river courses by a series of barbed tributaries.

1.2 Major Competing Beneficial Uses and their Impacts on Soil

a number of activities which rely on, and make use of the natural resource, soil, and have impacts on it (the soil) include these that are outlined below.

1.2.1 Crop Production

Owing to moderate temperatures, adequate rainfall and relatively fertile soil, Uganda's leading activity is agriculture. A wide range of food crops for both export and subsistence are grown. Traditional farm tools such as the hoe, axe and ox-plough, are used. Agriculture is such a dominant activity that it contributes over 50% of the Gross Domestic Product (GDP) and has maintained this position for a long period of time. In terms of foreign exchange earning it contributes over 80% of the total export earnings. Coffee is the leading export crop contributing about 60% of the total export earning.

This is rather a decline from its previous status where it constituted over 95% of total earning need to quote the period this 95% level.

The decline is a direct result of low world market prices, which in turn resulted from the collapse of the International Coffee Organisation (ICO) quota system in 1989. Other non-traditional cash crops are making up the gap in the export market. These include simsim seeds, soya, beans, vanilla and maize. Export of cut flowers and other horticultural crops is steadily increasing.

Cotton production is widespread in all regions of Uganda but remains a small-holder crop. It was most affected by the political turmoil which destroyed the cotton ginneries and the marketing system. Production is recovering but remains low at about 8,000 tonnes per year (1992) compared to 86,000 tonnes in 1970.

Tea production which is mainly a plantation estate activity was at sometime high but its production dropped from 23,000 tonnes (1972) to 1,500 tonnes in 1979. It has since recovered to over 7,000 tonnes.

Sugar-cane production has also improved following rehabilitation of the main sugar estates , namely, Kakira, Lugazi and Kinyara.

1.2.1.1 Impact 1: Land Degradation, and Soil Erosion

Loss of soil fertility: This is highly pronounced particularly in the highland areas which, however, are the more favoured agricultural areas, and in the rangelands. Soil erosion has occurred gradually but now its rate has increased owing to increase population. It has contributed to declines in soil fertility with subsequent reduction of agricultural yields and corresponding reduction in the economic gains.

Nutrient Loading and eutrophication: a secondary and important effect of soil erosion is the nutrient loading of water bodies. This has a negative impact on the fisheries and water quality.

Uganda is endowed with productive fresh water bodies which are in abundance constituting 17% of the total area of Uganda. Fishing is therefore, an important and relatively widespread commercial and rural activity carried out to meet the protein and cash needs of the population. Industrial scale fishing has also commenced, with establishment of fish processing factories aimed at the export market.

Fishing is an activity with a significant contribution to the foreign exchange earning to the tune of 5 million USD per year and is expanding. The major thrust includes increasing fish production, developing industries to supply the necessary inputs, promoting export and, improvement of processing and marketing.

The fishing activity needs to be protected through standards aimed at diminishing nutrient loading arising from soil erosion.

Siltation of rivers and lakes due to soil erosion: Serious soil erosion observed in many places as a result of the destruction of soil cover and cultivation on steep hill-sides has caused siltation of water bodies. The soil carried by water from the slopes to the water bodies causes sedimentation on the beds of lakes and rivers, gradually reducing their storage capacity, and flow. This therefore, reduces the economic value of the water bodies.

1.2.1.2 Impact 2: Land Fragmentation and Over-cultivation

Despite the existence of surplus arable land, there is a serious problem of land fragmentation. Close to 40% of agricultural holdings in Uganda are composed of two or more non-continuous small-holdings. Furthermore, 85% of the rural households produce both food and cash crops and raise livestock on holdings of less than 2 hectares.

Land fragmentation exists in all parts of the country but is most serious in the heavily populated districts of Kisoro, Kabale, Mbale, Kapchorwa and Bushenyi. Its most notable consequence is over-cultivation, very often without adequate soil conservation or regeneration measures. In addition, the traditional system of shifting cultivation or bush fallow - critical in restoring soil fertility - is now more difficult to practice. This situation has led to massive loss of soil through erosion and a rapid decline in soil productivity.

1.2.1.3 Impact 3: Inappropriate Farming Practices and Nutrient Loss

There are at least seven different farming systems in the country each with its own soil degradation problems **(Figure 3)**. The actual magnitude of the degradation in each system depends largely on population pressure, vulnerability of the soil to erosion, rainfall amounts and the general relief of the area. The most critical problem, however, is that the majority of farmers lack the knowledge and technology for improved farming.

For example, the practice of crop rotation has registered a downward trend; and most farmers grow the same crop on the same piece of land year after year, a situation which leads to serious soil degradation through nutrient depletion. Improved agro-forestry systems, capable of renewing and regenerating the soil, are also lacking in most farming systems.

Thus, this requires standards to be formulated to address such features of negative impacts on productivity of soil.

1.2.1.4 Impact 4: Mechanisation and Soil Compaction

Mechanization has been promoted as a means of increasing agricultural production. Despite its advantages, a number of problems are associated with the technology. First, the use of heavy machinery for land clearing and post clearing operation has caused soil compaction and correspondingly in some areas of the country and this has led to a decrease in water permeability and therefore a higher run-off. Consequently accelerated soil erosion has occurred. Secondly, the tractor operators are largely untrained and hence, do not have adequate knowledge and skill in operating such machinery to work the land and other related activities.

Soil compaction also occurs in the rangelands due to over-stocking and trampling along cattle tracks, resulting in soil erosion.

This phenomenon too requires to be addressed by standards.

1.2.1.5 Impact 5: Agro-chemicals and Destruction of Sub-soil Fauna

The residual effects of agro-chemicals on the country's environment are largely unstudied. Although purchased physical inputs (agro-chemicals, seeds and tools) represent less than 30% of the total cost of crop production, the use of pesticides is becoming widespread.

For example, the country's crop diversification policy, especially the encouragement of high value export crops, is likely to contribute to greater use of agro-chemicals.

Moreover, the major users of pesticides are small-holders who have had little, if any, training or skills in pesticide handling. When combined with chemicals used in the livestock industry and pesticides used to protect human health (such as, tsetse fly control), the total quantity of residual chemicals entering the environment is significant.

This phenomenon requires to be addressed by standards.

1.2.2 Livestock Production

a variety of animals are kept for both subsistence and for sale. The activity is dominated by small-holders (95% of production), and indigenous breeds are also being reared. Cattle are the dominant livestock type. Other livestock includes poultry, sheep, goats, pigs. Production levels are increasing and this is projected to increase in the future.

1.2.2.1 Impact 6: Overgrazing and Soil Erosion

Rangelands occupy approximately 84,000 sq km and are found in a corridor extending from Moroto and Kotido in the north-east, through the flat areas of Lake Kyoga, and South-westward to the Masaka and Ankole regions (see map). Close to 70% of the livestock in the country is in this cattle corridor and in the hands of traditional keepers, while the rest is commercial ranching.

In these areas, over-grazing is a serious problem. Particular areas affected are the counties of Ruhaama, Nyabushozi, Kazo, Buruli and the whole of the Karamoja region.

The resulting effects of over-grazing include soil compaction, soil erosion (particularly gully erosion) and the emergence of low-value grass species and vegetation with subsequent decline in carrying capacity and therefore, resulting in low productivity. Soil standards will play a vital role in reducing this negative impact.

1.2.3 Processing Industry

The processing industry is largely based on the processing of agricultural produce such as coffee, cotton, tea, tobacco, sugar, hides and skins, among others to prepare them for export or to produce commodities for home consumption. It consists of both small-scale and large-scale activities. Such activities as coffee-hulling, cotton-ginning, jaggery-making are small-scale; while the textile, sugar, and soap industries operate on are large-scale. It provides a two way linkage with agriculture.

The manufacturing and processing sector is in a poor state as a result of political turmoil and poor economic management. It barely contributes 8% of the GDP currently but this is projected to increase as a result of a deliberate industrialisation policy.

The factory machinery in some industries is obsolete and dilapidated, leading to inefficient production and heavy pollution. Most of the equipment was installed by Asian

entrepreneurs in the period 1950 - 1969. When the Asian Ugandans were expelled in 1972 the factories fell into disuse and some of these were looted during the wars.

Serious effort has been made to revitalise industry. The current _Medium-Term Sectoral Strategy - Way Forward II_ gives it a share of 15.7% (279.9 million USD) from the planned expenditure (1991 - 1995). The aim is to promote self sufficiency in consumer goods and develop better linkages with agriculture. Industry is now growing at about 7% per year.

1.2.3.1 Impact 7: Pollution

Small as the industrial sector's contribution to the GDP may be, its contribution to pollution of the water bodies is raising concern. A variety of effluents are released untreated to the water bodies by big industries located near them. Industrial chemical waste is dumped together with municipal waste, thereby causing contamination of land and the water table.

This situation requires to be addressed by standards.

1.2.4 Mining

Mining on commercial scale in Uganda started in 1907 and minerals like tin, wolfram, copper, lime, gold, gypsum, asbestos mica, quartz and kaolinite are being extracted. While most minerals were produced on small-scale, copper and limestone mining reached large scale levels in the mid-fifties. Most notable is Kilembe copper mine established in 1956, at the foot hills of Mount Rwenzori and the Tororo and Hima Cement factories established in 1954 and 1969, respectively.

During the period of copper production (1956 - 1977), 15 million tonnes of copper ore of 1.9% copper content were produced leading to production of 16,000 tonnes of blister copper per year. Along with this was cobaltiferrous pyrite (1.113 million tonnes) dump which has gradually been eroded in the course of 20 years into the surrounding land and water bodies in the Kasese area. Intensive mining activities are planned in the country's rehabilitation and development programme.

1.2.4.1 Impact 8: Pollution

The pollutants (metals) have polluted the surrounding land thereby entering the food chains of both animals and plants and this may have serious negative implications on the well-being of humans, animals, and plants.

The negative aspects on soil arising from mining activities therefore, need to be considered and addressed by standards with a view to preventing any such future incidents.

1.2.5 Forestry and Wood Industry

There are different biographic regions in Uganda which support a great diversity of flora. Over 5,000 different species of higher plants are found in these biographic regions. This is outstanding for a country as small as Uganda. Thirty of these species are endemic to Uganda.

Four types of forests arise from the biographic regions. The gazetted forests; savanna woodland, tropical high forest and montane forests.

Commercial wood extraction for timber now stands on average at 170,000 cubic metres annually for fine hard woods (Mahogany, Elgon Olive, Mvule).

1.2.5.1 Impact 9: Soil erosion as a result of inadequate forest cover

As a result of loss of forest cover, soil is unprotected and soil erosion has therefore occurred. This is widespread. It is necessary to prevent such loss of soil cover in order to protect the soil.

CHAPTER 2

2.0 REVIEW OF DOCUMENTS AND STANDARDS

2.1 Development of Soil Standards and Agricultural Land-use Guidelines in Uganda

Early attempts to establish land-use management guidelines were preceded by land inventories to establish the status of the Uganda soil resource base. Resource inventories started in 1933 (Martin, at Kawanda) and the limited results were embodied in the "Provisional Soil Map of East Africa" compiled by Milne (1935). Between 1935-1954 several attempts were made to improve the first soil map so that appropriate land-use management guidelines (especially for agricultural land use) could be put in place. The first detailed country-wide resource inventories were carried out during the reconnaissance survey (1955-1960) by the Soil Unit at Kawanda. Geomorphological surfaces on which the soils were formed was a major criterion used in soil survey and classification and the mapping unit employed was the series and soil catenary associations. Most of the present Soil Conservation Bye-Laws and Land Management Laws were based on information gathered during this survey.

The survey recognized 138 soil mapping units which were initially published in black and white soil maps at a scale of 1:500,000. These were later revised to produce more detailed 17 coloured soil maps at a scale of 1:250,000. The findings of the survey were published in six volumes of memoirs.

The memoirs contain a wealth of information which has partly been the basis for the establishment of critical values (thresholds) for soil chemical and physical parameters. Laboratory data on selected pedons are given, outlining soil texture, exchangeable bases, soil reaction, organic carbon, and available phosphorus. Comments are made on some nutrient values, whether they are very high or too low for normal crop production.

The memoirs grouped the soils of Uganda according to their suitability for major cash crops in 1959; namely, coffee, cotton, tobacco, tea, sugarcane, and cocoa. Additionally there were soil groupings for suitability for plantains. For each crop the soils were arranged in three categories:

- eminently suitable,
- suitable,
- barely suitable.

Unsuitable soils were not mentioned.

2.1.1 Soil Fertility and Productivity Rating

The report rated Ugandan soils in 1959, for their fertility and productivity. It pointed out that the fertility of the red tropical soils in Uganda was confined in the top-soil which is usually 23-36 cm deep. The report pointed out the loss of nutrients in the top layer and structure destruction as the most serious causes of soil degradation in Uganda.

It gave some guidelines on the management of soils by farmers in order to reduce soil degradation. The guidelines and recommendations include:

- grass-rest under elephant grass as a management practice for building up fertility and productivity of the soils;
- contour planting and cultivation, contour *paspalum*-grass bunding, contour strip cultivation on slopping land;

- application of farm yard manure; and,
- application of some selected chemical fertilizers.

These standard practices are valuable in controlling loss of soil fertility. Their enforcement must be urgently reactivated.

2.1.2 Drainage and Irrigation

The report rated internal drainage of practically all upland soils as being free-draining. It indicated that bottom lands were water-logged all through the year or some months of the year, and pointed out that most of the bottom-lands could be safely drained. The report, however, warned against draining and irrigating the acidic and leached bottom-lands in southern Uganda. The richer soils of the Rift Valley, the Sebei and Karamoja plains were rated as suitable for irrigation if water were available.

2.1.3 Standards for Plant Nutrients

The report classified soil concentration of individual plant nutrients which comprise soil fertility at three levels:

- very high
- high
- low

For each of the plant nutrients considered, Ugandan soils were grouped on the basis of which level of nutrient they belong to.

Between 1960-1970, considerable effort was put in the establishment of minimum chemical standards for soil fertility and productivity rating. Foster (1971), working at Kawanda, developed routine methods for soil chemical analyses and these were accompanied by the minimum chemical standards that have formed the basis for the present nutrient management guidelines for the whole country **(Table 1.1)**.

Table 2.1: A Guide to Analytical Results Obtained by the Routine Methods for 0-20 cm Soils in Uganda

Parameter/Analysis	Low Value	High Value
pH	5.2	6.2
Percent organic matter	3.0	6.0
Extractable P (ppm)	5	20
Extractable Ca (mg/100g)	35	200
Extractable K (mk/100g)	15	50

Source: Kawanda Soil Laboratory - Guide to Analytical Results

The low value indicates that a soil amendment (fertilizer) has to be recommended and will beneficial to most crops. Above the high value a soil amendment is unlikely to be beneficial to most crops.

Magunda (1994), proposed soil physical standards for the intensive banana-coffee-lake-shore farming system. These standards have since been validated in the other agro-ecological zones. These standards are to serve as an early warning signal of reduced productive capacity of soils or degradation. Specific physical parameters and threshold values were suggested for the surface layer and sub-soil. Standards should be viewed as a range of conditions where balance between exploitation and soil formation have moved away from a desired balance (Leonard *et al* 1990). Consequently the goal of soil quality standards is to maintain, restore or enhance the inherent long-term soil productivity.

2.2 Development of Soil Standards by Other Countries and Agencies

The demands for the kind of soil map and data vary, from one user to another. Some users are searching for the most suitable soil for growing particular crops. Others are interested in management and improvement inputs that puts their land to the most efficient use. There are yet other soil data users who need the data for locating home sites, waste disposal sites, roads, highways, and legislative land-use controls.

Soil Survey Manual, Agricultural Handbook 18, of USDA published in 1951, was revised in 1962, and attempted to meet the various demands of soil data users. The Soil Survey Staff of the Soil Conservation Service (SCS) revised the Soil Survey Manual, Agricultural Handbook 18 and published Soil Taxonomy in 1975 (USDA, 1975). Several chapters deal with soil data and standards. The book has been revised in 1994 with new soil data and soil standards. Some chapters in these publications concentrate on methods being used to interpret soil surveys. Much of the information is in the *"how to"* form and supplement many materials on soil standards in other later publications.

Agricultural Compendium was published by EuroConsult (1989). Many of the chapters are in *"how to"* form. Chapter 2, in particular, deals with chemical and physical soil standards. Extensive literature on soils and soil standards are cited in the publication.

Food and Agricultural Organisation (1971) published Guidelines for Soil Description and these were revised in 1977 (FAO, 1977). Much of the chemical and physical soil

standards are borrowed from USDA's Soil Survey Manual (1951) and revised version (1975).

Significant effort has been made to develop soil standards at international level. The following are of particular importance. Those measurable soil properties that are important for assessing the soil plant root environment are reported by Bartelli, (1979) as:

- effective depth of root ramification zone;
- texture;
- organic matter content;
- salt content;
- cation exchange capacity;
- base saturation;
- mineral content;
- permeability;
- saturated and unsaturated conductivity;
- soil wetness (drainage); and
- depth to water table and available water holding capacity.

Wischmeir *et al* (1969), reported soil texture, soil organic matter, soil structure and permeability as most influential soil properties on soil erodibility.

Stewart *et al* (1975), designed Universal Soil Loss Equation (USLE) to predict annual soil losses from sheet and rill erosion on specified field slopes. The equation is most useful for comparing erosional control systems that match a tolerable soil loss rate (T). The tolerable soil loss rate (T), is based on the acceptable level of erosion that the soil can sustain and with modern management can maintain soil productivity over reasonable length of time. The most durable soils are assigned the highest T-values. The soils with highest T-value have over 2 metres of favourable sub-soil. The sub-soil has no toxic substances and, with good management, has physical properties needed for abundant growth.

Bartelli, (1979), reported the ability of the soil to remove cations and anions, decompose organic matter and filter out and kill bacteria and viruses. He concluded that the efficiency of the soil is conditioned by the amount of clay, the cation exchange capacity, the pH, soil permeability or hydraulic conductivity, aluminium sesquioxides ratio, soil moisture, soil temperature, carbon/nitrogen (C/N) ratio, soil texture and aeration. He also noted that those soils best suited for growing crops are best suited for waste treatment.

Soil Survey Manual (Soil Survey Staff, 1951) analyzed land features that influence soil behaviour as:

- slope;
- flooding;
- wetness;
- rockiness; and,
- geomorphological position.

Slope is important in that it influences soil erodibility and water run-off, equipment manipulation, street lay-out, under-ground conduits, harvesting of wood products and land levelling (Bartelli, 1979).

Soils performance data are being used increasingly in many countries to develop plans for both urban and rural areas. Much of the data is primarily edaphic. They reflect the impact of the soil properties in the natural soil. The USDA Land Capability Classification (Klingebiel *et al* 1966), is an example of a standard based on soil performance. The soil ratings in this system are based on the degree of hazard or limitation to cultivated crop-use that result from soil factors influencing erosion.

The Canadian Land Capability System is similar to the USDA Capability System (The Canada Land Inventory, 1972; McCormack, 1971). There are seven classes and thirteen sub-classes in the system.

In 1977, USDA developed the Land Inventory and Monitoring System (LIM) to inventory and evaluate the nation's best farmlands. The LIM system defines Prime Agricultural Land, Unique Farmland, Additional Farmland of State Importance, and Additional Farmland of Local Importance.

The Tulare County, California, Planning Department initiated a Rural Valley Lands Plan (RVLP) in its County, as a method of designing lands with high or low development priority from the stand-point of preservation of agricultural lands and accommodation of urban growth. The system ranks land on basis of points.

More complex parametric methods of land evaluation have been introduced by Sys and Riquir, (1980). The systems use quantitative terms to express land evaluation. These systems also are edaphic in that soil properties are evaluated according to their importance between and within each other. These relations are expressed in a mathematical formula to calculate a final performance rating.

Other systems such as Land Utilization Types (Beek, 1978; Beek and Bennema, 1972) evaluate, in addition to edaphic features, socio-economic factors such as skill of operators, cost of overcoming limitations, environmental impacts, environmental demands of the people and the level of technical know-how.

Table 2.2: Main Characteristics of Land-Use Systems in Uganda.

Land use Systems	Intensive Banana-Coffee Lake shore System	Western Banana - Coffee - Cattle System	Forest-Savanna Mosaic Banana - Coffee System	Kigezi Annual Food Crop Montane System	Medium Altitude Intensive Banana - Coffee systems	The Northern And Eastern Cereal-Cotton Cattle System	The West Nile Cereal Cassava- Tobacco System
occasion	S. Mukono, Rakai, E Masaka, Mpigi, S.E. Mubende, S. Luwero, Ssese Islands, Kampala/ Entebbe, Jinja and Iganga	Rukungiri, Bushenyi, W. Mbarara and Kabarole (outside the Rift Valley and without northern part)	Most of Hoima and Masindi, N. Kabarole, Central Mubende, S. Luwero, N. Mukono and most of Kamuli	Kisoro, Kabale, and part of Rukingiri districts (above 1800 m)	Parts of Bukonjo and Bwamba counties on Rwenzori slopes, slopes of Mt. Elgon, Rukiga county in Kabale, Okoro County in Nebbi	Parts of Gulu, Apac, Lira, Soroti, Kumi and Mbale; and whole of Tororo	Western part of Arua district including Vurra, Ayivu, and parts of Koboko and Terego; parts of Nebbi.
Rainfall (mm)	1250-1500	1000-1500	1000 - 1500	1000 - 1500	1000-1500	1000-1500	1250-1500
Mean ann. max.t °c	25 -30	22.5 - 25	27.5 - 30	23	23-25	27.5-32.5	30
Mean ann. min. t (°C)	15	12.5 - 15	15 - 17.5	10	20	17.5	17.5
Altitude (m)	1000-1200	1200 - 1800	1050 - 1500	> 1800	1500-1800	1000-1200	1000 - 1500
Relief	flat topped hills, broad valleys, gentle slopes	gentle to steep sloping hills; broad valleys	undulating plateau	steep hills, narrow valleys	steep slopes with narrow valleys	undulating plains with hills and Inselberg	undulating plateau
Soil type	Ferralsols, Gleysols	Ferralsols, Acrisols, Nitisols Andosols, Gleysols	Ferralsols, Gleysols	Andosols, Nitisols Ferralsols, Gleysols	Andosols, Nitisols Ferralsols Acrisols, Gleysols Leptosols	Ferralsols, Gleysols Fluvisols	Ferralsols, Nitisols Loptosols
Population density (on potential arable land	high	high in Bushenyi, Rukungiri, Kabarole; low in E. Ankole	low	high	high	low to medium	medium to high
Approx. Farm size (Ha)	1-1.5	1-2, high density 4-15, low density	average 2 excluding fallow	<1	1-1.5	2-6	1-2
Tenure	freehold (predominant)	cropland: customary privately owned; grazing land: customary and privately owned if fenced; non-faced areas communally grazed	cropland: customary privately owned; wooded savanna: mostly customary communally owned	cropland: customary privately owned hilltops and swamps: customary privately owned, communally grazed if not fenced	cropland: customary privately owned swamps and steep slopes: communally owned	cropland: customary privately owned; grazing land and swamps: customary communally owned and grazed	cropland: customary privately owned; grazing land, swamps: customary communally owned and grazed
Labour	family, hired off-farm employment (estates, town, fishing)	family, hired and communal labour	family, communal migrant labour for first clearing	family, male off-farm in other areas	family male off-farm in other areas	family, communal labour (north)	family, communal

CHAPTER 3

3.0 DRAFT SOIL QUALITY STANDARDSDRAFT SOIL QUALITY STANDARDS

3.1 Soil Quality Standards for Agricultural Land Use

An agro-ecological-farming systems approach is followed as a basis for recommending soil quality standards (SQS), and focuses on the main soil types within the particular farming system. The soil quality standards are derived on the basis of inherent land qualities and land-use potentials. Soils are grouped into categories according to their suitability (current or potential) to specified types of sustained (agricultural) use, taking into account attributes and constituent factors, as well as land qualities made up of the latter. The major farming systems are shown in **Fig 3.1** and their main characteristics are summarised in **Table 3.1.**

It is important to note that SQS are applied during:

- Project planning;
- Project implementation; and,
- Project evaluation or monitoring.

The following classification of agricultural land is proposed for Uganda (rain fed agriculture):

- Prime agricultural land (High value land).
- Good agricultural land.
- Medium agricultural land.
- Marginal/fragile agricultural land.
- Low value/Unsuitable agricultural land.

Prime agricultural land is defined as land with the least management problems apart from nutrient management. Maximum inputs yield maximum outputs on prime agricultural land. For the seven (7) farming systems, in Uganda, the dominant soil types are designated to the classes as per parameters in **Table 3.1**.

Table 3.1: Soil Qualities and Classes for Rain-fed Agriculture

Quality/Parameter	I Prime	II Good	III Medium	IV Marginal	V Unsuitable
1. Bulk density (upper limit)	1.25	1.3	1.5	1.65 or 1.25 (wetlands)	high
2. Porosity (Vol. %)	53	51	43	38 or 53 (wetlands)	low
3. WHC (mm of H_2O/m soil)	>150	130 -150	100- 130	<100	low
4. Infiltration Rate (mm/hr)	60-100	40-60	40-10	<10	low
5. Permeability (mm/hr)	50-80	40-50	40-10	<10	low
6. Slope (%)	0 - 3	3 - 8	8 - 13	13 - 20	>20
7. Stoniness (vol%)	<0.1% (>30 m apart)	0.1% 10-30 m	<1% 10-30 m	1-3% 10-30 m apart	>15% of the surface covered
8. Soil depth (cm)	>100	75-100	75-20	<20 cm	very shallow
9. Flooding and duration (months/year	N.L.	N.L.	Slight to moderate >1-2 months	Moderate to severe 2-4 months	Very severe (>4 months)
10. Depth to water table	N.L. >150 cm	N.L. 50 - 150 cm	Slight limit. 100 - 100 cm	Shallow 25 - 50 cm.	Shallow 0 - 25 cm.

N.L. Not Limiting

Note: If a soil falls in the classification III to V it should not be used for rainfall-fed agriculture unless mitigation measures have been met.

3.2 SOIL QUALITY STANDARDS FOR SPECIAL CASES

3.2.1 Acid Sulphate Soils (Sulfaquents)

Acid sulphate soils are formed when the quantity of sulphuric acid, resulting from oxidation of reduced sulphur compounds, exceeds the acid neutralizing capacity of absorbed bases and easily weatherable minerals to the extent that the pH drops below 4. Potential acid sulphate soils become acidic as a result of drainage because the reduced sulphur compound (pyrite) is very stable under anaerobic conditions.

Pyritic papyrus peats are common in Uganda (for example, Kabale swamps). Accumulation of ferrous monosulfide (FeS) and ferrous disulphide or pyrite (FeS_2) occur in a highly reducing environment (anoxic). This process is especially prominent in the presence of mobile iron and abundance of organic matter, and under conditions of a ready supply of sulphur.

On drainage (improved aeration) atmospheric and microbiological oxidation convert the iron sulphide into ferric oxide and sulphuric acid, resulting in an extremely acid soil reaction, with pH well below 3-5, and occasionally as low as 1.0.

3.2.1.1 Diagnostic field characteristics of (potentially) acid sulphate soils

The following tests are required before drainage of wetlands:

- Potentially non-acid sulphate soils are those that contain sizeable quantities of neutralizing cations, mainly Ca. The presence of Ca (and Mg) carbonate should be tested using diluted HCl; the CO_2 given off will cause effervescence.
- The diluted HCl test may give rise to the characteristic odour of hydrogen sulphide, indicating the presence of sulphide in the soil.
- Bluish-black colours of fresh mineral soil may point to the presence of pyrite.
- Acid - tolerant vegetation may be indicative
- Treatment of potentially acid sulphate soils with hydrogen peroxide causes a prominent drop in pH of the soil. This decrease may well be 1-2 units lower than that which develops under natural oxidation.
- Slow oxidation by the regular exposure (drying) of the moistened soil samples (air drying) over a period of several weeks gives a fair simulation of the natural process and the resulting soil reaction (pH).

3.2.1.2 Reclamation of acid sulphate soils

Reclamation by chemical improvement of acid sulphate soils requires 20-30 tons of lime per hectare. The cost of purchasing, transporting and application of such large quantities of lime for the reclamation exercise is high and can be justifiable only in few cases. Moreover, large quantities of lime create problems of potash and trace element deficiencies.

Leaching is a better solution but no land should be flooded with the drained-off water. Additional measures to be taken include: regular applications of small amounts of lime, together with basic fertilizers (not containing sulphates) and ashes; cultivation of acid-tolerant, shallow- rooting crops; mounding of land in the case of more deeply rooting crops and good water-table management.

3.2.1.3 Irrigation

The soil qualities considered important for irrigation purposes are the following:

- topography (slope);
- wetness - flooding and drainage characteristics;
- physical soil characteristics:
  - texture (includes surface and subsurface)
  - soil depth,
  - salinity and alkalinity.
  - infiltration; and,
- soil chemical characteristics .

The qualities mainly relate to irrigation of crops normally grown under rain-fed conditions and give particular attention to soil-water plant relationship. These qualities are not applicable to drip irrigation. The soil chemical qualities are, as per earlier recommendation, on the general threshold values for fertility management.

The five classes of agricultural land proposed for irrigation normally fall under rain-fed conditions together with the

limits of the soil properties considered important in the classification and are shown in **Table 3.2**.

It is important to note that some of the recommended parameters are normally assessed in the field, that is, some parameters have no quantitative values, for example, drainage classes, soil structure, among others.

Since most water sources in Uganda are not affected by salt, it is assumed that the irrigation water will also be free of salts. Salt content of irrigation water is expressed either as: parts per million (ppm); milligrammes of salt per litre (mg/l); or, as electrical capacity expressed as microOhms per centimetre (Ec.x10^{-6}). High calcium carbonate and gypsum levels occur in very localised areas in Uganda and hence, no values are included in Table 3.2

Class I - Suitable.

Class II - Moderately suitable.

Class III - Marginally suitable.

Class IV - Potentially suitable.

Class V - Unsuitable.

Table 3.2: Soil Qualities and Classes for Irrigated Agriculture.

PARAMETER	I	II	III	IV	V
1. Slope (%)	<2%	2-5%	5-8%	8-12%	>12%
2. Wetness					
- flooding	N.F	Slight or less	-		
- internal drainage	Mod. rapid	Mod. V. rapid	Slow to V. rapid		
- natural drainage	good	good	Mod.		
3. Physical					
- top soil texture (0-25 cm)	SL-CL	LS-C	S-C	S-C	Cm to S
- sub-soil texture (25-100 cm)	SL-CL	LS-C	LS-C	S-C	Cm to S
- surface stoniness (vol%)	<0.01	0.01-0.1	0.1-3	3-15	>15
- substance course fragments (vol%)	0-5	5-15	15-20	20-25	>25
4. Salinity/alkalinity (0-100 cm)					
- Ec mmhos/cm	<1	1-4	4-8	8-15	>15
- EXP (0-100 cm)	<4	4-10	10-20	20-25	>25

NF: no flooding Mod.: Moderate. SL: Sandy loam; LS: Loamy sand:
C: Clay Cm: Massive clay S: Sand

Source : Adapted and Modified from Sys (1993).

If a soil falls in the classification III to V, it should not be used for irrigated agriculture unless mitigation measures have been met.

3.3 Wetlands Rice Systems

The wetlands rice systems have been grouped into two broad categories:

- rice cultivation under natural flooding or waterlogged areas; and,
- irrigated rice systems.

The natural flooding or water-logged systems represents the small-scale rice producers in periodically flooded alluvial plains and valleys in Tororo, Iganga, Pallisa districts, among other districts. These systems depend on flooding from rainfall. The irrigated systems represent the large-scale systems where irrigation waters are "fairly" well regulated. These rice production systems are adapted to specific hydrologic conditions and specific soil qualities. The first category is very widespread in eastern Uganda and it is the main cultivation pattern in wetlands.

The following are suitability classifications of soils for natural water-logged rice production system based on landform, flooding and physical soil properties:

Class I - Suitable.

Class II - Moderately suitable.

Class III - Marginally suitable.

Class IV - Potentially suitable.

Class V - Un suitable.

The five suitability classification for natural water-logged rice production systems, together with the soil properties and their limits are shown in **Table 3.3**. The five suitability classification for wetland rice irrigated systems where the irrigated waters are regulated, together with soil properties considered important in the classification are shown in **Table 3.4**.

Table 3.3: Soil Qualities and Classes for Wetland Rice Systems Under Natural Flooding.

PARAMETER	LAND CLASSES				
	I	II	III	IV	V
1.	**Slope**	N.L.	<2%	<4%	<6% <6%
2. Wetness: - Flooding - Drainage	 3 -4 months Poor	 3-4 months Poor to imperfect	 <2 months V. Poor to moderate	 <1 months V. Poor to moderate	too short or too long V. Poor to good
3. Physical: - surface text./structure - Subsurface text.	 Cm to SiCs Cm to LSf	 Cm to SCL Cm to Sc	 Cm to Sf —	 Cm to Sf —	 Cm to Sc —
4. Salinity/alkalinity: - Ec (mmhos/cm) - ESP (%)	 <1 <4	 <4 <10	 <6 <20	 <6 <25	 <6 <25

Note: *Cm: Massive clay* *SiCs: Silty clay blocky* *SCL: Sandy clay loam*
Sf: Fine sand *Sc: Coarse sand* *Lsf: Loamy fine sand*
N.L: Not limiting *V.P: Very Poor*

Source: Adapted and modified from Sys, (1993).

Table 3.4: Soil Qualities and Classes for Wetland under Rice Irrigated Systems

PARAMETER	LAND CLASSES				
	I	II	III	IV	V
1. Slope	<1%	<2%	<3%	<4%	<5%
2. Wetness: - Flooding - drainage	 N.L. Mod. to IP	 N.L. Good to poor	 3-4 months Good to V.P	 3-4 months –	 too short or too long –
3. Physical: - Surface, texture, structure - Subsurface texture/structure	 Cm to SiCs Cm to LSf	 CM to SCL Cm to Sc	 Cm to Sf –	 Cm to Sf –	 Cm to Sc –
4. Salinity/Alkalinity - Ec (mmhos/cm) - ESP (%)	 <2 <5	 <4 <10	 <6 <20	 <6 <35	 <6 <35

Note: *Cm: Massive clay* *SiCs: Silty clay blocky* *SCL: Sandy clay loam*
Sf: Fine sand Sc: Coarse sand Lsf: Loamy fine sand
N.L: Not limiting *V.P. Very Poor* *I.P. Impermeable*

Source : Adapted and modified from Sys (1993).

Note: If a soil falls in class IV to V, it should not be used for growing wetland rice under irrigation systems unless mitigation measures are met.

4.0 PARAMETERS AND METHODS OF DETERMINATION

There are a variety of soil parameters used for the management of soils, some of which are as outlined below:

4.1 Chemical Parameters

4.1.1 Soil Acidity (pH)

The parameter generally denotes soil reaction which expresses the degree of "acidity" or "alkalinity". The pH value equals the negative logarithm of the H^+ ion concentration (C_{H+}). Conventionally, the soil pH is measured in a soil - water suspension 1:2.5 (10 g soil in 25 ml water) and is designated pH (water). It could also be determined in suspensions of 1:1 or 1:5.

For the measurement of exchange (reserve or potential) acidity of acid soil a 1:2.5 suspension is used to which a neutral salt (KCl) has been added, in order to bring exchangeable H-ions into solution. It is designated pH (KCl). The pH values of a soil is most accurately measured with a pH meter in the laboratory.

4.1.2 Organic matter

Organic matter, because of its colloidal nature, contributes to the cation exchange capacity, (CEC) and therefore, the nutrient retention capability of the soil. Organic matter improves the physical characteristics of the soil through its enhancement of water permeability and retention. Soil organic matter is high in organic carbon and serves as a source of energy for soil micro-organisms.

Organic carbon is commonly determined by the modified Walkley and Black method (Nelson, D.W. and Sommers, L.E.)

4.1.3 Sodicity (ESP)

Normal soils usually have an exchange complex that is dominated by Ca and Mg and has only minor amounts of K and Na. When excess soluble salts accumulate in such soils, Na frequently becomes the dominant cation in the soil solution, a part of the original Ca and Mg is replaced by the cation. In general, physical properties become increasingly unfavourable with increasing levels of exchangeable Na.

The commonly determined parameter is the exchangeable sodium percentage (ESP).

$$ESP = \frac{\text{Exchangeable Na (meq/100 g soil)} \times 100}{\text{Cation Exchange Capacity (meq/100 g soil)}}$$

4.1.4 Salinity (Ec)

Saline soils contain soluble salts in concentrations that impair crop growth. Although weathering of primary minerals is the source of nearly all soluble salts, accumulation of these on the spot are seldom concentrated enough to form a saline soil. Invariably, strong salinity is found under semi-arid climatic conditions in soils where salts from other locations have accumulated through the inflow and subsequent concentrations of salt-bearing waters. Most saline soils are characterised by a low humus content, no differentiation into horizons and poor structure.

A generally accepted parameter of salinity is the electrical conductivity (Ec) at 25°C. The Ec can be determined according to the saturated paste extract method and measured with a conductivity bridge.

4.1.5 Cation Exchange Capacity (CEC)

The CEC of a soil often indicates its natural fertility and its

ability to supply Ca, Mg, and K for plant growth. It is also a measure of the ability of the soil to store added nutrients (fertilizers). Soils which have a low CEC cannot store large amounts of plant nutrients and must be replenished more regularly.

In the inorganic part of the soil complex only clay particles play a decisive role, since the active total internal surface of silt and sand particles in comparison to that of clay is very small. The CEC of clay depends on the type of clay mineral. The organic matter complex (the humus colloids) has a much higher CEC than clay.

The CEC of a soil is determined, in the laboratory, either in an exchange medium with pH = 8.2 or in exchange medium with pH = 7.0. Some times the expression T value is used instead of CEC value.

4.1.6 Exchangeable Bases

This is restricted to the cations Ca, Mg, K, and Na. The total quantity of these four exchangeable cations (S value) can be related to the CEC value and expressed as the base saturation percentage (BSP). The individual values for exchangeable Ca, Mg, and K give certain indicators of the fertility status of the soil (Macro-nutrients). The exchangeable Na percentage (ESP) is an important criterion for sodic conditions.

Exchangeable cations are determined in the laboratory by flame photometry for K and Na, and by atomic absorption spectrophotometry (AAS) for Ca and Mg (Anderson and Ingram, 1993).

4.1.7 Phosphorous (P)

Compounds of P (ADP and ATP) act as energy sources in plants. Energy from photosynthesis and metabolism of carbohydrates is stored in these compounds for subsequent use in growth and reproductive processes. The role of P as a structural component of a wide variety of biochemical and seed formation are also important.

Phosphorous is commonly determined by the calorimetric method (Anderson and Ingram, 1993); Olsen for extractable P and Bray II for available P.

4.1.8 Calcium carbonate

The presence of $CaCO_3$ affects both the physical and chemical characteristics of a soil. High lime concentrations may not severely restrict water movement but may prevent root penetration. A high $CaCO_3$ concentration particularly in the very fine fractions brings risks of lime-induced chlorosis for many crops. The physical characteristics of calcareous soils change when they are irrigated. It is therefore, a vital soil quality parameter under irrigated agriculture.

4.1.9 Gypsum ($CaSO_4$)

Gypsum indirectly affects soil physical properties and therefore, influences permeability and infiltration rate. It improves the structure and prevents sodium saturation. A small amount of gypsum is favourable for crop growth because it serves as a source of Ca as a plant nutrient and replaces Na in the exchange complex and thus, acts to soil's chemical and physical characteristics.

4.2 Physical Parameters

4.2.1 Texture

Soil texture refers to the particle size distribution and to particle-size groupings within specific ranges. Textural classes are defined by the relative contents of the three major soil separates, sand, silt and clay. Texture is considered as one of the most important characteristics with regard to physical soil qualities. It influences such important soil properties as soil water availability, infiltration rate, drainage, tillage conditions and capacity to retain nutrients. The effect of texture on those properties may be modified by structure, nature of clay minerals, organic matter content, and lime content.

Texture is commonly determined by the hydrometer or pipette methods in the laboratory or by the hand-feel method in the field.

4.2.2 Structure

Soil structure refers to the aggregation of primary soil particles (sand, silt, clay) into compound soil particles or clusters of primary particles which are separated from the adjoining aggregates by cracks or surface of weakness. Soil structure exerts a dominant influence on soil's air and moisture regime, on its hydraulic conductivity and consequently, on the root growth and (micro)biological activity that occurs within the soil. It is therefore, an important factor in soil productivity and soil genesis. Structure is commonly described in the field under three criteria, namely:

- grade which refers to the distinctiveness and durability;
- size of aggregate; and,

- shape of aggregates.

4.2.3 Coarse Fragments or Stoniness

Surface coarse fragments in the top 20 cm will influence tillage conditions as well as the capacity to retain nutrients and water. Coarse fragments can limit the use of agricultural implements and optimum growth of roots. Coarse fragments with a diameter between 2-75 mm are termed gravel; those between 75-250 mm are called cobbles and those more than 250 mm are called stones (Sys *et al*,1991).

Coarse fragments are commonly quantified on volume or weight percentage basis.

4.2.4 Rooting Depth

Rooting depth is a crucial parameter in soil productivity because it determines soil reserves of water and nutrients. The relationship between rooting depth and productivity is commonly described according to law of diminishing returns. It is generally defined as the thickness of loose soil above a limiting layer (if any). Limiting layer is impermeable for roots and percolating water. Soil depth is vital for the anchoring of plants and provision of a favourable environment for plant root growth.

Soil depth parameter is commonly quantified by direct depth (length) measurements.

4.2.5 Water Holding Capacity (WHC) or Available Moisture Content (AMC)

This is the amount of water which a given soil horizon can store and is estimated from the difference between field capacity and the lower limit of plant available water (wilting point).

The field capacity (-1/3 bar) and wilting point (-15 bar) are commonly determined in the laboratory by the pressure plate method. The field capacity value could also be determined in the field by the ponding method.

4.2.6 Drainage and Depth to Water-table

Drainage and depth to water-table are vital parameters. The suitability for upland crops decreases when drainage conditions become impeded. Tree crops with a deep root system are more sensitive to poorly drained conditions than annual crops with shallower root systems. Crops like paddy rice react quite differently to drainage conditions; their suitability decreases when drainage conditions improve. For irrigated agriculture, drainage, depth to ground water- table and salinity status are critical evaluation parameters.

Drainage classes are normally described in the field; depth to water-table is also measured in the field.

4.2.7 Slope

Slope angle and length are critical parameters for the assessment of erosion potential. It also influences water movement and distribution within the soil profile.

Slope angles or percentages are determined in the field.

4.2.8 Infiltration

Infiltration is a very important parameter irrigated farming systems. Infiltration is the entry of water into the soil through the soil surface. The rate is dependent on the antecedent moisture, soil structure, pore sizes and their distribution. It is an important parameter in evaluating compacted (physically degraded) soils, for example, degraded rangelands. Rate of water entry is generally very low in degraded areas and most of the water ends up as run-off; causing considerable soil erosion and siltation problems.

Infiltration rate is commonly determined in the field using a double cylinder infiltrometer (Bouwer, 1986).

4.2.9 Bulk Density

This parameter largely depends on the porosity of the soil and is commonly used to evaluate compaction. Loose and porous soils have low values while compacted or physically degraded soils have high values.

Bulk density parameter is conveniently determined by the core or clod method (Anderson and Ingram, 1993).

4.2.10 Total Porosity

Total porosity is the fraction of the soil mass that is occupied by the pores. The pore space is largely determined by the arrangement of the individual solid particles of the soil.

The pore space in the soil is partially occupied by the liquid (water) and partly by air.

Porosity is commonly computed from the relationship between bulk density and particle density (Anderson and Ingram, 1993).

4.2.11 Flooding

Flooding is considered as a serious limitation for most crops apart from paddy rice. Flooding interferes with the air entry into the soil.

For paddy rice cultivation flood evaluation is based on duration and depth of flooding.

Optimal duration of flooding is 110 to 160 days; marginal situations are 90-110 days and more than 180 days. The optimal depth can be considered as 10-30 cm (Sys *et al.* 1991).

4.3 Soil Conservation Guidelines

Soil conservation is considered on a holistic basis as activities and techniques of environmentally sound production of food, wood, and other commodities based on sustainable use of land, species and ecosystem. The soil erodibility hazard potential for Uganda is depicted in **Figure 4.1** (UNEP/GRID/1987). In all these areas a combination of several conservation practices are recommended and packages will depend on area and crops/ livestock/tree species on the land.

4.3.1 Lowlands and Flat Areas (Slopes up to 2%)

Lowlands are the alluvial plains and the bottom-lands of small tributaries in a catchment. The following soil conservation structures and practices are recommended :

- surface or subsurface drainage;
- interception and diversion ditches;
- rows of crops should be laid out at right angles to the contour lines;
- crop rotation; and,
- fertility improvement (package will depend on crops and area).

Diversion ditches or field ditches should be at a spacing of 100 to 200 metres; depth of 30 cm; and, length not more than 500 metres. These should be laid out slightly off the contour to obtain a gradient of 0.3 to 0.5%. The collecting ditches (depth 60 cm), should drain into main ditches or natural drainage ways and should run in the direction of the greatest slope.

4.3.2 Undulating to Hilly Topography (Slopes of 3 to 15%)

Recommended conservation practices:

- contour cultivation;
- contour ridges or absorption banks at a spacing of 30 m;
- grass strips and strip cropping; width 30 m;
- mulching;
- agroforestry;
- crop rotation and fertility improvement;
- wind breaks or shelter belts should be located perpendicular to main erosive wind direction.

4.3.3 Steep Topography (Slopes 15 - 60%)

Simple conservation practices are insufficient to stop erosion and following management practices are recommended:

- terraces;
- contour cultivation (ploughing and planting along the contour), and absorption banks at a spacing of 10 - 20 m;
- crop rotation and fertility improvement;
- strip-cropping, with strip width of 10 to 20 m;
- agro-forestry.

4.3.4 Pasture and Rangelands

4.3.4.1 Pasture

- contour furrows at small distances (20 m);
- interception ditches;
- stone cordons : loose stones on the surface collected and deposited on contours;
- silt-traps, built from stones or soil in small depressions;

- pasture and fertility improvement.

In addition, an optimum stocking rate is required. Areas with fertile soils and rainfall amounts of >850 mm per year - 2 cows per hectare recommended; areas with low fertility and rainfall of <850 mm per year - 1 cow per hectare. Pasture species and animal breeds are additional considerations.

4.3.4.2 Rangelands

These recommendations are particularly targeted at the "Cattle Corridor". Recommendations will depend on state of rangelands. These include:

- re-vegetation or re-seeding - closing the area to grazing and allow natural grasses to establish or re-seed with suitable species of grasses and legumes;
- gully control with mechanical barriers (dry reeds, vegetation, stones, etc);
- controlled or rotational grazing;
- run-off harvesting - divert and impound run-off to prevent soil erosion, gully development and allow slow permeability into the soil;
- fertility improvement; and,
- remove low value grass and tree species to allow nutritive species to proliferate and cover bare ground.

CHAPTER 5

5.0 IMPLEMENTATION REQUIREMENTS

a quantitative approach has been proposed to protect soils. With this approach chemical, physical and biological parameters or standards, of soil quality have been developed and should be used as guidelines for protecting soil quality. Emphasis is on prevention of degradation, loss and restoration of degraded soils, that is, overall emphasis is on long-term sustainability. Soils are a finite resource on which society is intimately dependent. Acting now to protect this resource will ensure that there will be sufficient soils of known quality and functionality to support generations to come.

Enforcement of soil quality standards will have to be implemented with a concerted effort between soil science practitioners and policy-makers. Increased public awareness of the value of soils and the collection and presentation of data on the status and future of soil resources in Uganda will advance the development of sound soil protection policy. Soil scientists should be leading in protecting soils.

5.1 Institutional Arrangements

NEMA has to contract the quantification of the soil quality parameters to institutions with efficient laboratories and appropriate man-power. These institutions are:

- National Agricultural Research Organisation, (Kawanda);
- Makerere University (Soil Science Dept. - FAF);
- Makerere University (Chemistry Dept. - Pesticides);
- Laboratory of the Government Chemist - Pesticides); and,
- National Bureau of Standards - Consumer Products Standards.

5.2 Frequency of Monitoring

For purposes of enforcing standards, Table 5.1 gives guidelines on the monitoring frequency.

Table 5.1: Suggested Frequency of Monitoring Soil Quality Parameters for Enforcement Purposes

Soil parameter	Suggested monitoring frequency
(a) Soil physical indicators:	
- Bulk density and porosity	- Annually
- Structure	- 2 years
- Texture	- 3 years
- Water holding capacity	- 3 years
- Infiltration	- 3 years
- Coarse fragments and stoniness	- Annual
- Soil depth	- Every 5 years
- Slope, depth to water table, and drainage class	- 3 - 5 years
(b) Soil biology indicators:	
- Soil organic matter	- Annually
(c) Soil chemical indicators:	
- pH	- Annually
- Exchangeable bases	- 2 years
- P	- 2 years
- CEC	- 2 years
- Calcium carbonate and gypsum	- Planning phase
- Alkalinity, Sodicity (for irrigated agriculture)	- 3 to 5 years

Source: Adapted and modified from Lal, (1994).

5.3 Costs Involved

Soil quality standards are applied during project planning, project implementation and project evaluation or monitoring. All the proposed parameters are very ideal for the project planning phase but might be too expensive for project evaluation or for continuous monitoring purposes. **Table 5.2** gives indicative [current] costs for a complete assessment of 10 ha of a degraded farmland. The costs are based on a minimum number of samples per hectare. Field labour and professional costs are not included.

Given the high costs involved in monitoring of these standards it is proposed that for monitoring purposes the chemical and biological parameters proposed in **Table 5.2** are ideal for assessing changes in the fertility status. The following parameters are proposed for the monitoring of changes in physical status: bulk density and porosity, structure, texture and soil depth.

Table 5.2: Indicative Cost ($) for a Complete Assessment of a Degraded ten Hectares of Farmland

Samples or determination of cost	Total for 10 ha. per ha.	Parameter	Sample
(a) Soil physical indicators:			
Bulk density and porosity	4	0.5	20
Structure	2	0.5	10
Texture	10	1.0	10
Water holding capacity	5 (10 ha.)	10	50
Infiltration	5 (10 ha.)	10	50
Coarse fragments	5 (10 ha.)	0.5	2.5
Soil depth	5 (10 ha.)	0.5	2.5
Slope, depth to water table and drainage class	5 (10 ha.)	5	25
(b) Soil biology indicators			
Soil organic matter	5	1	50
(c) Soil chemical indicators			
pH, P, Exch. bases, and CEC	5	20	1000
Total Cost For a Ten Hectare Farm		**$1,220**	

CHAPTER 6

6.0 STANDARDS FOR LAND-USE IN URBAN AREAS STANDARDS FOR LAND-USE IN URBAN AREAS

Uganda now has an estimated population of 19.26 million people out of which 2.31 and 16.95 million live in urban and rural areas, respectively. This population is growing at an annual average rate of 2.5% (National), 5.0% and 2.31% urban and rural, respectively (Habitat II, 1996). The high urbanisation rate is characterised by the fast rate at which new urban centres are mushrooming beyond the national capacity to plan and guide development. This has led to a gradual urbanisation of some rural areas and agricultural farm lands, without the provision of infrastructure and services reminiscent of urban disorder and attendant environment problems.

While urbanisation progresses, it is increasingly using up good agricultural land. As a result there is serious competition between land-use for agriculture and land-use for urbanisation. In order to ensure rational use of land it is necessary to put in place comprehensive zoning of land-uses to realise a National Physical Development Plan. The country is lacking such a comprehensive land-use plan. It is only after such zoning has been done that it will be possible to protect prime agricultural land and other natural resources such as soil, water, forests, among other resources.

Table 6.1 indicates the growth of urban centres from a total of 28 in 1969 to 92 in 1991. This situation requires planning controls.

Table 6.1: Growth of Urban Centres in Uganda, 1969 to 1991

No. of Centres Population ('000)	1969	1980	1991
Above 500	0	0	1
100 - 499	1	1	0
50 - 100	0	0	2
20 - 50	3	7	13
10 - 20	6	4	14
5 - 10	8	10	26
2 - 5	10	26	36
Total Number of Centres with 2,000 + Population	28	48	92

Source: 1991 National Population and Housing Census Report

The high rate of urban population growth in Uganda is attributed to the following factors in order of importance:

- Rural - Urban Migration.
- Natural Population Increase.
- Extension of Urban Boundaries.
- Urban farming.

6.1 Land-Use Planning

The body responsible for over-seeing the orderly development of all urban and rural areas in Uganda, is the Town and Country Planning Board.

The Board links up with the District Councils as the Planning Authorities at policy level. This involves co-operation in the preparation of structure plans (broad land-use development framework) for the various urban centres. Detailed schemes are then developed by the technical committees headed by the respective Town Clerks. The Committees cannot endorse any planning scheme without the knowledge of the Board. In rural areas, the District Development Committees are supposed to aid the Board.

The law governing physical planning is the Town and Country Planning Act Cap. 30. Although the Physical Planning Department serves as the technical arm and secretariat, there is no mention of it and its functions. This is an anomaly that could lead to operational problems.

The Physical Planning Department has the responsibility to undertake planning of all urban and rural settlements in the country. Unfortunately, due to lack of personnel and inadequate resources, its work has greatly been limited to major urban centres to the neglect of small and intermediate centres and rural areas.

In case of area planning, no place can be subjected to planning regulations unless it has first been gazetted into a planning area. For regional and district plans, the plans must be approved and passed by the Board before they can be legally enforced. Due to lack of personnel, the regional planning function has not been executed.

Consequently, there is no National Physical Development Plan, no Regional Development Plans and no District Development Plans for a comprehensive use of the land resource. Hence, the numerous land-use conflicts and the increasing deterioration of the environment. It is important to note that none of these plans can be prepared before a national land-use survey has been undertaken.

6.2 Planning Standards

For a rational utilisation and protection of land resources standards have been developed to ensure sustainable use. In the development of these standards Kampala City has been the main area of study. Being the biggest urban centre in the country, what applies to Kampala is generally replicated in the other urban centres. Hence, a lot of reference will be made to Kampala in the ensuing text.

There are several areas to consider when developing planning standards, and some of these considerations are outlined below.

6.2.1 Industrial Land

Principles for locating sites include:

- good transport links;
- proximity to high density residential areas;
- dispersal in various parts of the urban area;
- they should be on relatively flat land; and,
- soil characteristics (stable foundations).

Most of the flat areas were swamps and poorly drained areas, some of which are at present forest reserves. The present major industrial areas of Nalukolongo, Kinawataka, Nabisasiro, Ntinda/Nakawa of Kampala are in wetlands contrary to current environmental legislation.

The projected space requirements are determined by projected future population and an assumed density of employees per hectare. In the 1994 Structure Plan, the assumed density was 50 - 100 workers per hectare. Unfortunately, very small-scale industries widely scattered in the commercial and residential districts were not provided for.

6.2.2 Residential Land-Use

Housing in urban areas takes the greater proportion of land in relation to other urban activity areas, often over 35%. The different urban land-uses in some American cities are indicated in **Table 6.2**. Though this is a reflection of

the highly urbanised world, Uganda is following the unstoppable urbanization trend, and is therefore expected to follow suit.

Table 6.2: Land-Use Allocation in Urban Areas

User	% Percentage
Residential	35 - 39
Commercial	4.8 - 5
Industrial	10 - 11
Streets/roads	20 - 26
Open Spaces, Schools, Parks etc.	10 - 18

Source: Eisner and Associates Studies, 1939 - 85, in Harland Bartholomew. Land-uses in American Cities, Harvard University Press.

6.3 Density Controls

The Kampala Structure Plan, 1994, gazetted on 31st December, 1996, proposed that there should be five different densities of residential area, as listed in **Table 6.3**.

Table 6.3: Residential Densities, Kampala

Density	Minimum Density		Maximum Density	
	Persons Per hectare	Persons per Acre	Persons per Hectare	Persons per Acre
Low	-	-	30	12
Medium-Low	30	12	75	30
Medium	75	30	150	60
Medium-High	150	60	250	100
High	250	100	-	-

The prescription for high density housing areas was a minimum standard of services compatible with a habitable environment. This meant housing with communal service cores built within 50 metres of every dwelling with a maximum of 250 people served by one core with each core providing:

- 16 toilets (maximum of 16 people per toilet);
- 10 showers (maximum of 25 people per shower);
- 4 taps; and,
- 2 large washing slabs.

On account of insufficient funds this constituted a minimum rather than a desirable standard.

Increase of densities is contingent upon further sub-division of large plots along with improved public utilities.

6.4 Standards for Provision of Social Facilities

6.4.1 Health Facilities

The standards for health facilities proposed in the Kampala Structure Plan, 1972, were mainly based on the findings of a symposium held at Makerere in 1966, under the auspices of WHO and UNICEF (Medical Care in Developing Countries, M. Kingl, but with a number of modifications to suit conditions of Kampala. These modifications had been made after discussions with the Kampala City Council Medical Officer of Health and after surveys at Naguru and Kiswa Health Centres had been carried out. (See report - Standards for Social Facilities, Health, Schools).

The health centre is basic unit of medical care to serve a population of 40,000 in a range of 2.5 km from potential users; situated on 1.6 Ha (4 acres).

6.4.2 Education Facilities

The structure plan concentrated mainly on calculation of planning standards for primary and secondary schools. The school standards had been agreed upon by the two authorities responsible, mainly KCC and Ministry of Education (M.O.E).

The land requirements were based on a number of assumptions:

(a) 15% of city population will be primary school age (6 - 12 yrs);

(b) 12% of city population will be secondary school age (13 - 18 yrs);

(c) there would be a stable urban population, that is, few children sent outside and few coming in for schooling;

(d) a maximum of 40 students per class;

(e) a maximum of 3 streams per primary school, giving a maximum enrolment for a primary seven school of 840 students;

(f) there will be a maximum enrolment of 2000 students for a secondary school; and,

(g) sufficient sites should be allocated for universal primary and secondary education even though

universal education may not be achieved during the plan period.

6.4.3 Site Requirements

- A minimum of 1 ha (2.5 Acres) land per stream of primary, and 3 ha for 3 streams. A small reduction in these standards would be permissible if the land is flat and dry, and thus completely usable, and if there are other schools and open spaces adjacent, whose facilities could be used jointly.

- Secondary school requirement was put at 6 ha (15 acres); not catering for staff and student accommodation. Schools were to be day not boarding.

6.4.4 Open Space Facilities

Three main open space facilities have been identified to cater for a full range of out-door leisure activities. Firstly, there must be open space for sports; secondly, amenity open space for quiet relaxation; and thirdly, small play spaces for young children. The objective is to make sure that land is not overloaded to set in motion the process of soil deterioration arising out of rapid loss of vegetation.

Provision of these sports facilities (based on British Standards - highly urbanised) and modified to Kampala conditions requires an allocation of approximately 0.3 ha. (0.8 acres) of land per 1,000 people.

The standard amenity open space proposed is 0.4 - 0.8 ha. (1 to 2 acres). In medium - to high density areas special provision for children play spaces becomes necessary. That 0.2 ha (0.5 acres) of play space per 1000 people should be provided in all housing areas with density of 75 or more persons per ha (30 people per acre).

In addition to the lake-shores and valleys, which provide much of the future open space, two other types are generally suitable. They are the hill-tops with fine views over the City and surrounding areas, and sites with some particular historic or religious attraction, for example, Kampala Old Fort or Natete/Busega Martyrs Memorial Ground, and others.

6.4.5 Drainage and Sanitation

Under the Public Health Act the drainage and sanitation rules provide for the proper disposal of foul water from premises so as not to pollute the soils with a view to protecting water resources.

6.4.6 Institutional Strengthening (improve to relate to soils)

To be able to ensure environmental integrity, local authorities must emphasise the role of land use planning. Urban space must be planned for before development. Hence, steep slopes, wetlands and other sensitive areas should be zoned for protection with the necessary mitigation measures put in place where development cannot be avoided. Hence, the requirement for an environmental impact assessment (EIA). Since soils are not easily restored, it is imperative that activities that impact on them (such as, mining, quarrying, construction) are conducted with adequate precautions. In construction for instance, care should be taken not to destabilise soils on steep slopes so as to avoid triggering off land-slides, silting and eventual flooding in the low lying areas.

A comprehensive National Land-use Plan will go a long way in ensuring the rational utilisation of soil and land resources and help avoidance of land-use conflicts arising out of competing uses. In this way, resources will be optimally utilised and protected for posterity.

Housing in urban areas takes the greater proportion of land in relation to other urban activity areas, often over 35%. The different urban land uses in some American cities are indicated in **Table 6.2.**

CHAPTER 7

7.0 WASTE MANAGEMENT STANDARDS

Soils can be easily polluted directly and indirectly by wastes. This can happen as a result of air and water pollution since this will inevitably end up in the soil. Polluted soils then have a direct linkage with human health and the environment. Plants take up pollutants from the soil into their tissue and humans and other animals that feed on plant tissue then take up the pollutants into animal tissue. Pollution of the soil therefore, reaches Man through the food chain. In order to control the daily intake of pollutants for humans, it is necessary to control waste accumulation in soil.

Alarming soil pollution by hazardous materials with disastrous known effects has been experienced in Uganda and was identified by the NEAP process to be present at Kasese (cobaltiferrous dump) and Tororo (asbestos dump) and in both cases injudicious waste disposal was the cause.

Waste management remains a problem in Uganda and statistics on the subject are inadequate; however waste dumping is predominant and hazardous materials find their way into the dumping sites. What comes to mind about this quality of waste management therefore, is the stench, the *kaveera* (polythene bags) and paper littering all the dumping sites with rat infestation and scavenger birds and animals living around the waste dumps, from which oozes out a corrosive leachate heading to the nearest stream. Both the local authorities and the private sector that render the service are responsible for this situation.

In order to protect human health and the environment it is necessary to institute proper management of this activity.

7.1 Goal

The main goal is the attainment of adequate and consistent management of hazardous wastes across the country. To do this requires establishment of standards to be achieved and the practices to be adopted. The main thrust is to ensure facilities and the practice.

7.1.1 Objective

To protect and preserve the quality of fresh water and protect plants from pollutants translocated through soil.

7.1.2 Strategies

- To ensure management beyond the waste producers premises covering both the public and private sectors.
- To coordinate the operations of the waste producers, waste disposal contractors, and waste disposal authorities and to introduce professionalism into these activities.
- To ensure use of adequate technology to achieve the correct performance.

The area of most concern is the waste tipping dumps and land-fills serving commercial and densely populated areas. Chemical waste incineration will be mentioned together with the processes to be enforced.

Definition:

(a) Hazardous material:

a material that represents a threat to human or animal health or to the environment;

7.2 SCOPE AND ACTIONS

In order to avoid consequent release of potentially highly polluting leachate, land-fills will have to be operated with

the full knowledge of the scientific and technical information, and the civil engineering works that underpins the controlled dumping and land-fill disposal of hazardous wastes. Consequently it is necessary to consider the aspects outlined below.

7.2.1 Licensing Process

Establish a licensing procedure for producers and dealers and for sites used. Under this, the site should posses a valid planning permission which in turn should be based on criteria for the prevention of danger to health, and the pollution of soil and water. Conditions to be imposed in the licence include:

- extent of stripping and storage of top-soil and sub-soil for later use to cover up;
- types of materials to be accepted and the rate of filling;
- the working hours for land-filling and restoration;
- direction of tipping and extent of the working face;
- keeping records of all activities including deposition;
- layering of waste and use of compaction equipment;
- fencing and gates, site accommodation and provision of services;
- description of operational techniques to deal with particular wastes;
- description of measures to deal with land and water pollution by leachate;
- description of measures to deal with gas emissions and/or migration of toxic agents from;
- cover materials both intermediate and final;
- progressive restoration plan; and,
- monitoring.

The licence should reflect the statutory requirements and these should be prepared after careful consultation with all stake-holders.

7.2.2 Inspection Process

Establish an inspectorate and in particular the post of a HAZARDOUS WASTE INSPECTOR in NEMA as part of a specialised environmental inspectorate with the following goal and duties:

Goal

To ensure that the standards of waste disposal sites, licensing, operation, monitoring and enforcement are adequate to protect health and the environment.

Duties

- To examine on routine basic, the management of waste at all its stages from the starting point to that of final disposal by visiting facilities being used to handle, store, treat, process, and dispose of such waste.
- To investigate potential occurrences with a view to determine causes and preventive solutions.
- To advise waste disposal authorities on the execution of their duties.
- To make recommendations with the object of ensuring that standards of operation, site licensing, and enforcement are adequate to protect health and the environment, that they are equitable and consistent across the country.
- To liaise with all Government institutions that have a role to play in the field.
- To publish an annual report.

7.2.3 Fundamental Statistics

Establish the fundamental statistics by carrying out a study: on the total quantity of hazardous waste generated in the country, its types and sources, its geographical distribution, and its patterns of movement and disposal;

7.2.4 Registration Process

Establish a register of all facilities, sites licensed or authorised to deal with wastes.

Such facilities include:

- Landfill
- Transfer Station
- Storage
- Incineration
- Lagoon

- Recovery
- Treatment
- Civic Amenity
- Mineshaft
- Sludge Land Farm
- Reception Pit
- Baling
- Soakway
- Solidification
- Evaporation Pit

Each of these facilities should have a record of the location and of waste deposits to it. Any unauthorised tipping of waste and should therefore, be banned.

7.2.5 Institutional Responsibilities

Establish a functional hazardous waste disposal unit located in the Town Planner's Office in each urban authority. The duties of the waste dispersal unit include:

- to undertake a waste survey in its area and prepare a waste disposal plan;
- to control disposal sites by the issue of site licences;
- to ensure compliance with the site licence conditions; and,
- to administer the requirements of the Environment Management Statute.

7.2.6 Site Selection

Ensure scientific site selection and evaluation. Before licensing, it is essential for the operator to perform a detailed site investigation so that soil and hydrological characteristics are identified and consequently areas unsuitable for wastes are avoided **(Table 7.1)**. The important site parameters to be used include:

- Land use
- Hydrology (surface, subsurface)
- Geology
- Soil properties (physical, chemical, hydraulic)
- Topography
- Climate (wind, temperature, moisture)

Table 7.1: Unacceptable Site Characteristics for Hazardous Wastes Disposal.

Parameter	Unacceptable Characteristic
Geology	• bedrock out-crops • irregularities (fissures, faults overlaying ground-water)
Hydrology	• aquifer recharge zone • flood prone areas • wetlands • seasonally high water tables • near community water supply wells or reservoirs
Climate	• extremely wet conditions • extremely cold conditions
Topography	• broken terrain • steep slopes
Soils	• thin soil above ground water • highly permeable soils above shallow ground-water
Land Use	• areas formally used for land-fills • areas contaminated with persistent residues from past waste treatment • areas designated for parks, wildlife refuges, endangered species, prime agricultural land, historic sites
Location	• areas of high risk from natural or man-made disasters

7.2.7 Site Mapping

Ensure that a land-fill site is mapped at a scale of 1 : 250 with 1 metre contour intervals. The map should show:

- the proposed fill area;
- any burrow area;
- access roads; and
- drainage devises;

This should include any other information which will show the planned development, operations and completion of the land-fill.

7.2.8 Site Monitoring: Standards for Monitoring Leachate

- The performance of the land-fill in holding waste has to be monitored at least once every 1 year.
- Leachate monitoring should not be confined to the land-fill itself, but should also take place outside the land-fill boundary.
- Monitoring must continue beyond the closure of the land-fill, for at least 5 years.
- The standards for the leachate should not exceed the values shown in **Table 7.2.**

Table 7.2: Standards for Indirect Discharge from Landfills

Parameter	Value	Unit
Arsenic	0.2	mg/l
BOD_5	30	mg/l
Cadmium	0.5	mg/l
Chlorine (active)	0.2	mg/l
Chromium (III)	0.2	mg/l
Chromium (IV)	0.05	mg/l
Cobalt	0.5	mg/l
COD	50	mg/l
Copper	1.0	mg/l
Cyanide (volatile)	0.2	mg/l
Cyanide (total)	0.1	mg/l
Fluoride	2	mg/l
Halogenated hydrocarbons	0.5	mg/l
Hydrogen Sulphide	1	mg/l
Iron	10	mg/l
Lead	0.2	mg/l
Mercury	0.05	mg/l
Mineral oil	20	mg/l
NH_4/NH_3-N	5	mg/l
Nickel	0.02	mg/l
NO_2-N	5	mg/l
Organic pesticides	0.05	mg/l
pH	6.5 - 8.5	
Phenol (as C_6H_6OH)	0.2	mg/l
Phosphate	10	mg/l
Polychlorinated biphenyls (PCBs)	0.001	mg/l
Selenium	0.05	mg/l
Settleable solids	1	mg/l
Silver	0.05	mg/l
Suplhate	200	mg/l
Temperature	30	°C
Zinc	0.3	Mg/l

Note: This Table has been harmonised with the UNEP-IRPTC Legal File 1992 - 1993, the Lake Victoria Environmental Management Programme proposals, and the Water Legislation Study Extension.

7.2.9 Site Closure

Site closure must be planned with detailed considerations equal to site development and operation. The following must be assured:

- adequate supply of final cover and top-soil;
- elimination of residual leachate problems;
- capping the site after refuse has been built to its final level to prevent rain-water ingress and weathering;
- landscaping; and,
- planting of trees.

7.3 Priority Wastes and Processes to be Enforced

This list is selective in that attention is directed to substances that must be disposed of with great care.

The criteria for selection includes the intensity of their:

- Effects on health
- General population exposure
- Environmental effects
- Environmental exposure

All wastes containing such substances should be notifiable to the inspector.

7.3.1 Polychlorinated biphenyls (PCBs)

PCBs are used in transformers, capacitors, heat transfer and hydraulic systems. The main users are the Uganda Electricity Board (UEB), and the main motor garages.

7.3.1.1 Control Measures

General measures:

a) All PCB transformers should be marked. The mark should show the PCB content in ppm.

b) All PCB transformers should be leakproof.

c) PCB transformer stations and storage sites containing 45 kg and above of PCBs should be licensed and notifiable sites.

7.3.1.2 Storage

a) Establish a proper storage facility and this includes:

- adequate roof and walls to prevent rain-water from reaching the stored material and items;
- adequate floor with a continuous curbing (minimum 6" high). This must provide a containment internal volume twice that of the largest article to be stored;
- no drain valves, floor drains, expansion joints, sewer lines or other openings that would permit liquids to flow from the curbed area;
- the floor and curbing should be constructed of continuous smooth and impervious materials such as portland cement concrete to prevent penetration of PCBS; and,
- the storage facility site shall be located above flood water level.

b) Utilise proper PCB containers for storage; with the following:

- steel drum without a removable head designed, constructed, and operated with safety requirements for flammable and combustible liquids;
- manage the store in accordance with marking, record keeping, and inspection requirements;
- removal from store and disposed of within 1 year.

7.3.1.3 Disposal of PCBs

- All PCB liquids and industrial sludges with PCB concentration of 500 ppm or greater must be incinerated.
- On no account must even small amounts of spillage be flushed into the surface water drainage system, or any water courses, or sewers unless they lead to a hold- up tank or treatment plant.
- Containers must be disposed of in a chemical waste land-fill provided it is drained the first place.

Definitions

(a) Spill:

Intentional and unintentional and other uncontrolled discharges, where the release results into any quantity of the PCB running off or about to run off the external surface of the equipment or container; as well as contamination resulting from the release.

(b) Spill area:

The area of soil on which visible traces of the spill can be observed, plus a buffer zone of 0.05 metres beyond the visible traces.

Spills are uncontrolled discharges to the environment and should be dealt with as follows:

- cleaned off to restore the site on land to its original state at the cost of the person who causes spills to occur;
- cleaned up promptly. Any leaks must be cleaned up within 48 hrs from the time of discovery. The operator must show and be prepared to implement a Spill Prevention Control and Counter-measures;
- all soil within the spill area must be excavated and the ground to be restored to its original configuration by back-filling the area with clean soil (less than 1 ppm of the PCB);
- any contaminated indoor residential surface must be cleaned to 10 microgrammes per 100 sq. cm;
- all contaminated solid surfaces must be thoroughly washed and rinsed; and
- at the completion of the clean-up, the responsible party must document the clean-up with records and certification of the decontamination to be maintained for 5 years. The certification must include:
- source of the spill (for example, type of equipment or process);
- date and time the spill occurred;
- date and time the clean-up was completed;
- description of the spill location;
- pre-clean-up sampling data used to determine spill boundaries;
- description of solid surfaces that were washed and method used;
- reasons for delay in clean-up in case it was outside the 48 hrs time frame;
- depth of the soil excavated and the amount of soil removed;
- a certified statement signed by the responsible party stating that the clean-up requirements have been met and that the information contained in the record is true to the best of the party's knowledge.

7.3.2 Asbestos

- ***Definition:***

  The term asbestos means the fibrous form of mineral silicate belonging to rock forming minerals of the serpentine group, that is, chrysotile (white asbestos), and of the amphibole group, that is, actinolite amosite (brown asbestos, cummingtonite-grunerite), anthophylite, crocidolite (blue asbestos), tremolite or any mixture containing one or two of these.

Activities that give rise to asbestos waste include:

- manufacture of products containing asbestos, such as asbestos cement roofing sheets and sewage pipes;
- stripping, repair or maintenance of products containing asbestos, such as brake linings of motor vehicles;
- demolition or repair of structures containing asbestos.

All these are realised in Uganda.

Uganda ratified the **ILO Convention No 172 (1986) Concerning Safety in the Use of Asbestos** in 1990. The standards therefore, already set in this, have to be implemented.

7.3.2.1 Disposal

- It must be emphasised that the land used for asbestos waste disposal will be useless for most purposes

afterwards. The choice of this land therefore, has to be made with greatest care.

- The process of collection and disposal of asbestos must be done only in the presence of and supervision of a Specialist in occupational hygiene.

- Health and safety at work during the disposal has to be ensured in particular:

  - protective clothing to be provided and used;

  - generally at high exposure, a full suit of protective clothing including head-wear, clothing and foot-wear;

  - material that is readily decontaminated, resistant to penetration and the design should be close fitting at the neck and waist, and it should not have external pockets or other attachments that can trap asbestos;

  - protective clothing should be worn only in the working area - it should never be taken home;

  - respiratory protective equipment should always be used. This must be capable of reducing the level of asbestos respirable dust in the breathing zone of the wearer below 0.2 fibres/cm^3.

    Information on the protection offered such as the respiratory equipment, should be provided by the manufacturer.

  - Bags used to hold asbestos should be of good quality, dust-tight, adequately sealed and should not arrive at the site in a raptured/torn state. The bags should be labelled (asbestos) and with the corresponding danger symbol. The international symbol for asbestos is EC 103:

    Risk phrase (R-Phrase) 103
    ("long or repeated exposure can cause cancer")

    Safety phrase (S-Phrase) 103
    ("Prohibit any exposure as best as you can").

- Any container used for disposal of asbestos waste should be made out of an impermeable material which is strong enough to remain dust-tight even under wet conditions. For loose fibrous waste or small fragments, double plastic bags are suitable. The inner bag should not be over-filled and each bag should be independently sealable.

- An asbestos dumping-site should be covered immediately after depositing waste asbestos.

7.3.3 Organic Pesticides

- Organophosphates and carbamates:

  Hydrolysis using an alkaline solution with water to destroy its toxicity. The large containers of the said pesticides can also be decontaminated by treatment with alkaline water solution followed by rinsing and steam cleaning.

- Chlorinated hydrocarbons:

  - Incineration at high temperatures.

  - Where incineration is not possible, entomb the pesticide in a refractory material such as cement, ceramic or asphalt.

7.3.4 Heavy Metals

These include: cadmium, chromium, copper, lead, nickel, zinc. Of particular interest for health purposes are: arsenic, antimony, mercury, selenium.

The required processes are:

- precipitation of heavy metals in an insoluble non-toxic form; and

- reduction of chromium(IV) to chromium(III).

7.3.5 Cyanides

Oxidation of inorganic cyanides.

7.3.6 Acids and Alkalis

- acid and alkali neutralisation prior to deposition. This should be done in trenches or lagoons constructed at the site;

- direct disposal can only be done if the following concentrations are followed:

  (a) sulphuric acid - less than 20%
  (b) nitric acid - less than 05%
  (c) chromic acid - less than 05%

7.3.7 *Phenols*

This also includes phenolic wastes such as cresol and xylenol. These are degraded in organic refuse under aerobic and anaerobic conditions only after long resident times (1-2 years).

- The loading rate in the land-fill should be kept to 2 kg of phenols to 1 tonne of refuse.

7.3.8 *Plastics, Polythene*

7.3.8.1 Background

As a consequence of the plastics era, there are a variety of plastics in our midst and the environment is heavily loaded with them. Of particular concern is polyethylene (polythene) and its use as carrier bags - *"Kaveera"*. This use is widespread throughout the country and is rampant in both rural and urban settlements. The use of ***kaveera*** far out-strips the use of all other plastics. The concern is over injudicious disposal onto soil.

Polythene is the same material often also called Polyethylene and locally called *"Kaveera"* in Uganda. It is a material made from a simple chemical called ethylene which in turn is obtained from distillation of petroleum. The manufacture of polyethylene from ethylene is done using a chemical reaction called polymerisation. (Polymerisation is the joining together of many small molecules (monomers) to make very large molecules (polymers)).

Polymers are ordinarily called *plastics* - a description of their peculiar behaviour and feel - they are soft, smooth but tough. Plasticity is a Physics word describing the behaviour of a solid whereby the solid undergoes permanent change in shape or size when subjected to stress. This is characteristic of plastics.

The chemical reaction polymerisation, leads to a variety of useful materials - plastics -in use in variety of activities of man. A few common examples are shown in **Table 7.3** below:

Table 7.3: Plastics (Polymers) commonly used

Monomer	Polymer	Use
Vinyl Chloride	Poly Vinyl Chloride (PVC)	Pipes, shoes, boots, tents, etc
Acrylonitrile	Polyacrilonitrile (Orlon)	Canvas for vehicles
Vinylidene Chloride	Polyvinylidene Chloride (Saran)	Seat covers (immitation leather)
Tetrafluoro ethylene	Polytetrafluoro ethylene (Teflon)	Chemically resistant containers
Chloroprene	Polychloroprene (Neoprene, Duprene)	Artificial rubber
Acrylic	Polyacrylic	Carpets, fibres, woven fabrics
Urethane	Polyurethane	Cushions, mattresses

7.3.8.2 Polyethylene Production in Uganda

The production of polythene bags in Uganda stands at about 700 tonnes annually from 13 different manufactures. The local production accounts for only 10-20% of local consumption. The rest of consumption is supplied through other countries. The level of importation is uncertain but some sources suggest 40,000 tonnes annually.

7.3.8.3 Environmental impact: Damage of Soil

All plastics are hazardous materials from the time they become wastes. This is a direct result of their physical properties, namely, that they are not degradable through the natural processes. As regards soil, the main impact arises when polyethylene ends up in the soil and it does not rot. The bacteria that are responsible for the rotting process of natural materials are not able to decompose polyethylene.

The chemistry of natural processes is equally weak to degrade polyethylene. The material is stable to water, non oxidizing acids and alkalis and therefore, natural acidity does not affect it. It is also non-permeable to water. When buried in the soil it thus, creates a micro-desert and plants in its vicinity experience moisture stress. Polythene therefore, enhances, soil degradation; because partly, polyethylene remains stable in the soil almost indefinitely.

It is emphasised that the waste disposal system in the country is inadequate. Waste disposal is inadequate in urban centres and it is virtually non-existent in rural areas. Consequently polyethylene is slowly but surely contributing to degradation Uganda's soils.

Furthermore, it must be emphasised that Uganda's economy is based on agriculture which in turn depends on good soil. Fertile soil is therefore, the most basic economic asset of Uganda. The soil should be jealously guarded. Polyethylene is attacking this important economic asset.

This type of soil degradation is already observable in suburbs of Kampala, Masaka, Mukono, Jinja, Mbale. These are corresponding to the heaviest monitorable use of polyethylene bags. The same can be said of any trading centre in the rural areas.

When polyethylene gets distributed into the soil as described above, there is no foreseeable technology or way of rendering it harmles. Prevention is the only action available.

7.3.8.4 The Objective

- To put into place adequate preventive measures through good waste management practices.

7.3.8.5 Strategy

- Increase public awareness and change public attitudes on use.
- Improve garbage collection with particular interest on polyethylene for destruction.
- Impose a controlled ban on the disposal of the material onto the soil.

7.3.8.6 Actions

- Require the users to collect and incinerate all used ***kaveera***; the incineration should be done out-doors in the open and at least a distance of 50 metres from the houses;
- Prohibit the dumping of ***kaveera*** on land other than an authorised land-fill;
- Require the manufactures and suppliers to inform the users on safe disposal of ***kaveera***.
- Assign the responsibility of ensuring compliance to the Chiefs (or Local Authorities) at rural level and to the urban authorities in towns.
- Encourage the manufacture and use of biodegradable materials, and where plastics must be used, encourage the use of biodegradable plastics and/or recycleable plastics in place of the common ***kaveera***.

7.4 Monitoring of Discharges from Land-fills

The following are a set of appropriate equipment to enable accomplish the job (monitoring) in a centralised laboratory

7.4.1 Analytical Laboratory Equipment

(a) Organic and inorganic materials:

- 1 Gas Liquid Chromatograph (HPLC) -one per National Centre.
- 1 ICP - AES/Mass Spectrophotometer- one per National Centre Metals.

- 1 Atomic Absorption Spectrophotometer with graphite furnace detector.

(b) General Laboratory equipment:

- 3 Quartz Double Water Distillation System
- 3 Reagent Water Deionisation System
- 3 Milli- Q Reagent Water Purification System
- Laboratory Glassware
- General Laboratory Equipment
- Laboratory Regents (Aristar Grade)
- Trace Analysis Solvents
- Carrier gases (argon, nitrogen, oxygen)
- Fuel gas (acetylene, oxygen)

The Budget Capital for establishment of a competent laboratory based on these items (excluding building costs) is 750,000 USD. The sample through-put would be 50 samples per day with analytical cost of 50 USD per sample.

7.5 Site Equipment and Costs

In order to achieve the best use of land-fills, it is necessary to have the right equipment in place. The necessary equipment is to perform the following tasks:

- levelling and preparation of the site;
- creation of access roads and manoeuvring spaces:
- digging and moving covering material;
- initial handling and segregation of in-coming waste;
- spreading and placing waste in the land-fill;
- covering the waste; and,
- final levelling and top-soil placement.

Invariably the equipment will be:

i) a tracked machine (such as a bull-dozer and loader) capable of digging, lifting and carrying material;

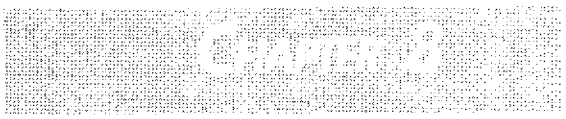
ii) a scraper for stripping out and stock-piling material;

iii) a drag-line excavator; for preparation and winning covering material from the site;

iv) a four wheel drive rubber tyred loaders for digging out cover and placing it into its final position;

v) a steel wheel mobile compactor for compacting the waste in its final place.

The budget based on these equipments at current prices is 670,000 USD excluding labour and taxes.



8.0 SUCCESS PROSPECTS

It is necessary to carry out an analysis of operating factors in order to have an idea of the success of the standards developed in this work. The basic analysis involves issues concerning:

- external factors; and,
- internal factors.

8.1 External Factors

For the external factors of which NEMA has no control, the basic tools of the analysis are:

Political, Economic, Social, and Technological, (PEST). The consolidated analysis is set out as outlined below.

8.1.1 Political

The rapid establishment of the National Environment Statute (1995), was a clear demonstration of the political support to NEMA as the implementer of the Action Plan in the country; and this political good can be an element that will contributes to success of these standards.

The emphasis on foreign investment in the country with a view to boost the economy will introduce new actors with different views into the scene of environmental management. Many of these may see the environment management efforts as an extra cost to their investment, and so may seek ways of circumventing the legal requirements.

The Structural Adjustment Programme and in particular, Liberalisation Policy, presents both an opportunity and a threat to the success of these standards. This policy is a strength, in that, many investors will come to NEMA for guidance and this is an opportunity to influence performance; but the limited financial support NEMA has will prevent it from giving effective guidance to the interested investor.

8.1.2 Economic

The agricultural sector is still the predominant economic sector in the country; however this sector is largely in the hands of the peasant. With the peasants_ limited appreciation or ignorance of the importance of the said standards, it will be an up-hill task to ensure compliance with the set standards.

Poverty is a serious problem in the country. Poverty has an intricate relation with environmental management. The poorer the society the less likely the environment will be managed properly because, poverty limits the society's ability to acquire the necessary knowledge and technology to manage the environment properly.

This has the effect of reducing the ability of the institution to ensure the protection of the soil (and other natural resources). The current efforts to eradicate poverty in the country will take time to yield results and meanwhile soil degradation will be influenced by the prevailing conditions.

The Government of Uganda is running a stringent budget as a result of factors such as external debt which requires large sums of money to be committed for debt servicing and balance of payments, hence, leaving little money for developmental activities. This has denied the institution adequate funds for proper operation; and so making it difficult to ensure compliance with the standards.

8.1.3 Social

The rural nature of the communities as mentioned above, is a constraint. The literacy level is low, the cultural attitudes as regards family sizes, and inheritance are contributing towards the land fragmentation and poor farming techniques hence, leading to land degradation mentioned in **Sections 1.2.1.2** and **1.2.1.3** above. This has the effect of increasing the work load for NEMA.

Demographic trends such as the rate of over 2.5% of population growth, is regarded high and that pressure on the land is increasing at a high rate (which NEMA is not in position to cope with at the current funding and staffing. This makes it difficult to ensure compliance). In addition to this, there is uncontrolled migrations arising from civil strife conflicts, which are leading to inadequately planned settlements and corresponding improper use of land; encouraging degradation of land resources, which these standards are supposed to correct.

Infrastructure and communications are not developed enough to enable easy monitoring of performance of the standards. This will contribute towards reducing the ability of the institutions to ensure compliance.

8.1.4 Technology

Agricultural technology is not improving at the rate that would support the implementation of these standards at the rural level, and yet this is where most of the degradation is being generated. In particular, not enough food is being produced for the communities. As a result is famine is experienced in at lease 12 districts in the country. Persons in famine situations will think least about soil management.

Communication technology in the rural areas including telecommunications, roads, railways, mass media (radio, newspapers and television), which are the most important tools for mobilisation of the public to]live up to the set standards, are not adequately developed. This state of affairs will reduce the success of these standards.

Laboratory competence for the necessary analysis is inadequate. Currently many prospective investors in the agriculture sector, especially in flower growing enterprise, are sending soil samples for analysis in Europe. This is not conducive to monitoring of standards.

8.2 Internal Factors

The analysis employs the following as criteria: strengths, weaknesses, opportunities, and threats (SWOT).

The key points are as follows:

- The most important strength of NEMA in implementing these standards is its structure as set up by law and the powers bestowed upon it. In particular, the vertical linkages and the horizontal linkages with the sectoral agencies. A determined Policy Committee on the environment, Board of Directors of NEMA, Staff of NEMA, the Environmental Liaison Units and the Districts is a force enough to ensure change.

- The biggest weakness, however, is the inadequate competent man-power and financial resources. It will take considerable time and funds to overcome these weaknesses, and any action plans that NEMA puts into place must address these weaknesses.

- There are considerable opportunities that NEMA can exploit to improve current operations and extend its success and impact on the productivity of soils. The current global concern for environment with willingness to fund activities, is a case in point. Hence, greater efforts should be pursued to achieve sustainable funding of NEMA operations.

- While the Board and the management of NEMA can do little to change the external factors that impact its operations named above, careful forward planning can mitigate the impact of these threats.

- The key efforts will be to:

  - attract investment into NEMA;

  - ensure effective utilisation of its current human resource;

  - ensure effective management and dissemination of information; and,

  - continue development of structure and motivation of staff.

The consolidated SWOT analysis is shown in **Table 8.1**.

Table 8.1: Consolidated SWOT Analysis

Strength	**Weaknesses**
	OVERALL:
. Strong and modern legislation. . The NEMA Board, top management are determined to succeed. . Strong leadership. . Improving morale. . New equipment (vehicles and computers, etc). . Improving public awareness. . Positive cash-flow of donor funds. . Action Plan present.	. Inadequacy of database. . Under-developed information systems. . Users and lead agencies do not provide adequate Information to NEMA. . Inadequate controls through standards. . Public perceptions and practices (historically poor, and politically oriented). . NEMA is under-capitalised.
	HUMAN RESOURCES: . Inadequate skilled and experienced staff. . Inadequate training in relevant skills (EIA, inspection, client care and advocacy skills). . Inadequate motivation and rewards to staff. . Unclear personnel policies. ORGANISATION AND STRUCTURE: . Weak interaction with ELUs. . Inadequate contact with some districts.
Opportunities	**Threats**
. Increased world concern on the environment. . Increased compliance with the law. . Investment opportunities for long-term projects under GEF. . New companies starting up with requirements of the Statute. . Capacity to "lobby" and influence legislation. . Commendable cooperation with other Government bodies/agencies.	. Unfavourable politicisation of issues. . Rapid turn-over of specialised staff. . Economic fragility causing indecision. . Government interference in technical decisions. . Potentially large unfunded activities. . Resistance to change. . Lack of ability to retain trained personnel (remuneration policy).

STATUTORY INSTRUMENTS

1999 NO. .....

THE DRAFT ENVIRONMENTAL STANDARDS (MINIMUM STANDARDS FOR THE MANAGEMENT OF THE QUALITY OF SOIL) REGULATIONS, 1999

(Under Sections 108 of the National Environment Statute, 1995)

Statute No. 4 of 1995

IN EXERCISE of the powers conferred on the Minister by Section 108 of the National Environment Statute, 1995 and on the recommendation of the Policy Committee on the Environment and the Board these regulations are made this ..... day of .....1999.

Citation

1. These regulations may be cited as the Environment Standards (Minimum Standards for the Management of the Quality of Soil) Regulations, 1999.

Purpose and scope

2. (1) The purpose of these regulations are -

(a) to establish and prescribe the minimum soil quality standards (SQS) to maintain, restore and enhance the inherent long term soil productivity;

(b) to give full effect to:

(i) article 245 of the Constitution;

(ii) section 3, subsection (2) of section 4, and section 31 of the Statute;

(iii) any other relevant provision of the Statute.

(2) More specifically, these regulations:

(a) establish minimum standards for the management of the quality of soil for specified agricultural practices;

(b) establish criteria and procedures for the measurement and determinations of soil quality;

(c) issue guidelines for the management of soil in order to ensure long term sustainability.

Basis for the establishment of soil quality standards under these regulations

3. (1) For the purpose of regulation 2, the soils are grouped into categories according to their suitability to specified types of sustained use.

(2) More specifically, the soil quality standards established under these regulations are based on:

(a) the agro-ecological-farming system;

(b) the main soil types within the particular farming system;

(c) the inherent land qualities and land use potentials; and

(d) for the purpose of regulations 4, 5, 6 and 7, the agricultural land (rain fed agriculture) as classified in Part 5 of the First Schedule.

Soil quality parameters for rain fed agricultural areas

4. (1) The soil quality parameters for rain fed agricultural areas specified in Column 1 of Part 1 of the First Schedule are as classified according to land classes in Column 2 of the Schedule.

(2)Without prejudice to the above, where the soil parameters under subregulation (1) falls in the classes III, IV and V of Column 2 the soil should not be used for rainfall-fed agriculture unless mitigating or improvement measures have been undertaken by the person responsible.

(3) The mitigating and improvement measures under subregulation (2) shall take into account the results obtained under the Second Schedule with respect to diagnostic field characteristics of, potentially, acid sulphate soils.

Soil quality parameters for irrigated agriculture

5. (1) The soil quality parameters for irrigated agriculture specified in Column 1 of Part 2 of the First Schedule are as classified according to land classes in Column 2 of the Schedule.
(2) Without prejudice to the above, where the soil parameters under subregulation (1) falls in the classes III, IV and V of Column 2 the soil should not be used for irrigated agriculture unless mitigating or improvement measures have been undertaken by the person responsible.
(3) For the avoidance of any doubt, the qualities specified under sub-regulation (1) of regulation 5 shall not apply to drip irrigation.

Soil quality for wetland rice systems under rice systems under natural flooding

6. (1)The soil quality parameters for wetland rice systems under natural flooding specified in Column 1 of Part 3 of the Schedule are as classified according to land classes in Column 2 of the Schedule.
(2) Without prejudice to the above, where the soil parameters under subregulation (1) falls in the classes III, IV and V of Column 2 the soil should not be used for wetland rice systems under natural flooding unless mitigating or improvement measures have been undertaken by the person responsible.

Soil quality for wetland rice under irrigated systems.

7. (1) The soil qualities for wetland rice under irrigated systems specified in Column 1 of Part 4 of the First Schedule are as classified according to land classes in Column 2 of the Schedule.
(2) Without prejudice to the above, where the soil parameters under subregulation (1) falls in the classes IV and V of Column 2 the soil should not be used for wetland rice systems under natural flooding unless mitigating or improvement measures have been undertaken by the person responsible.

Soil quality for special cases

8. The soil quality for special cases are as specified in the Second Schedule.

Soil parameters and procedure of determination

9. The soil parameters under these regulations are determined as specified in Part 6 of the First Schedule.

General prohibition

10. (1) No person shall manage the land in contravention of the soil quality parameters established under these regulations.
(2) No person shall drain a wetland before carrying out the tests specified in Part 7 of the First Schedule.

Soil conservation guidelines

11. (1) These guidelines are issued by the Authority in the exercise of its powers under paragraph (4) subsection (2) of section 31 of the Statute.
(2) In fulfillment of the duty under subsection (2) of section 4 of the Statute, every person has a duty to observe the soil conservation guidelines established under the Fourth Schedule.
(3) No person shall emit any substance into the soil beyond the maximum standards established under these regulations unless he or she has been so authorised under subsection (2) of section 58 of the Statute.
(4) A person wishing to emit any substance into the soil beyond the maximum standards established under these regulations shall apply to the Technical Committee on the Licencing of Pollution for a licence.

(5) The Committee under subregulations (4) shall consider the application as provided in Part VIII of the Statute.

(6) Without prejudice to the provisions of this regulation, the owner of the land or person residing on or using the land shall comply with the most suitable guidelines as specified in the Fourth Schedule and practice the mitigating measures specified for the particular topography, drainage and farming systems for that land as specified in the Schedule.

(7) A person who contravenes the provisions of this regulation commits an offence and is liable on conviction to the penalty specified in section 99 of the National Environment Statute, 1995.

Designation of Inspectors 12. (1) Subject to sub-section (1) of section 4 of the Statute, the Authority shall, on the recommendation of the Technical Committee on Soil Conservation established under Section 11 of the Statute, designate under section 80 of the Statute as many officers as it deems fit to be Environmental Inspectors to:

(a) ensure that the guidelines established under the Fourth Schedule are observed;

(b) ensure that the guidelines for the frequency of monitoring soil quality parameters in of the Third Schedule are observed;

(c) ensure that the soil quality parameters established under Part 1, 2, 3, 4 or 7 of the First Schedule are observed;

(d) issue an improvement notice requiring the restoration of the soil to ensure conformity with the parameters established under these regulations;

(e) perform any other function that the Technical Committee on Soil Conservation may recommend.

(2) An Inspector appointed under subregulation (1), a laboratory or person designated under regulations 13 may, at all reasonable times, enter on any land, to ensure compliance with the requirements of the soils quality standards under these regulations.

(3) In the exercise of the functions under subregulation (1), the environmental inspector may issue an environmental order as set out in the Seventh Schedule to ensure compliance with these regulations within the specified period.

(4) A person who fails to comply with an order issued under subregulation (3) is liable, on conviction, to the penalty prescribed in section 96 of the Statute.

(5) Any person who fails to observe the soil conservation guidelines established under sub-regulation (1) of this regulation is liable on conviction, to the penalty specified in section 99 of the Statute.

(6) Any person who destructs an Inspector in the performance of his functions under sub-regulation (3) of this regulation is liable to the penalty prescribed in section 96 of the Statute.

Designation of analytical laboratories, analysts and reference analysts

13 (1) The Authority shall under Section 83 and 84 of the Statute, designate by notice in the *Gazette,* the institution and persons to which functions under these regulations are assigned.

(2) The institutions or persons designated under sub-regulation (1) shall:

(a) comply with section 85 of the Statute and these regulations;

(b) be a competent institution for purposes of carrying out analysis or for analysis of soil samples for ensuring compliance with these regulations;

(c) be competent authorities for purposes of taking and analyzing samples in compliance with these regulations;

(d) be composed of persons drawn from any of the institutions specified in the Sixth Schedule.

Applicability of established standards

14 The soil quality standards established under these regulations shall apply during:

(a) project planning;

(b) project implementation;

(c) project evaluation, monitoring or closure

Monitoring

15. An Inspector designated under regulation 12 shall ensure that the standards established under regulations 5, 4, 6, 7, and 8 for the soil parameters are monitored as specified in the Third Schedule.

General Penalty

16. A person who contravenes any provisions of these Regulations commits an offence and is liable to the corresponding penalty prescribed under Part XIII of the Statute.

Interpretation

17. In these regulations unless the context otherwise requires.

"Authority" means the National Environment Authority established under Section 5 of the Statute.

"Executive Director" means the Executive Director appointed under Section 12 of the Statute and includes purposes of these regulations any person who has been authorised by the Executive Director to act on his behalf.

FIRST SCHEDULE

regulation 4

PART 1

Soil qualities and classes for rain fed agriculture

QUALITY/PARAMETER	Column 2 - Classes				
	I PRIME	II GOOD	III MEDIUM	IV MARGINAL	UNSUITABLE
1. Bulk density (upper limit)	1.25	1.3	1.5	1.65 or 1.25 (wetlands)	high
2. Porosity (Vol. %)	53	51	43	38 or 53 (wetlands)	low
3. WHC (mm of H_2O/m soil)	>150	130 -150	100- 130	<100	low
4. Infiltration Rate (mm/hr)	60-100	40-60	40-10	<10	low
5. Permeability (mm/hr)	50-80	40-50	40-10	<10	low
6. Slope (%)	0 - 3	3 - 8	8 - 13	13 - 20	>20
7. Stoniness (vol%)	<0.1% (>30 m apart)	0.1% 10-30 m 10-30 m	<1% 10-30 m apart	1-3%	>15% of the surface covered
8. Soil depth (cm)	>100	75-100	75-20 - -	<20 cm	very shallow
9. Flooding and duration (months/year	N.L.	N.L.	Slight to moderate >1-2 months	Moderate to severe 2-4 months	Very severe (>4 months)
10. Depth to water table	N.L. >150 cm	N.L. 100 - 150 cm	Slight limit 50 - 100 cm	Shallow 25 - 50 cm.	Shallow 0 - 25 cm

N.L. Not Limiting

FIRST SCHEDULE

regulation 5

PART 2

Soil qualities and classes for irrigated agriculture

Column 1: Soil Qualities	Column 2: Classes				
PARAMETER	**I Suitable**	**II Moderately Suitable**	**III Marginally Suitable**	**IV Potentially Suitable**	**V Unsuitable**
1. Slope (%)	<2%	2-5%	5-8%	8-12%	> 12%
2. **Wetness** - flooding - internal drainage - natural drainage	N.F Mod. good	Slight or less Mod. Rapid good	- Slow to very rapid Mod.	- Slow to very rapid imperfect	- Very Slow to Very poor
3. **Physical** - top soil texture (0-25 cm)	SL-CL	LS-C	S-C	S-C	Cm to S
- sub-soil texture (25-100 cm)	SL-CL	LS-C	LS-C	S-C	Cm to S
- surface stoniness (vol%)	<0.01	0.01 - 0.1	0.1- 3.0	3-15	>15
- subsurface coarse fragments (vol%)	0-5	5-15	15-50	20-25	>25
4. **Salinity /alkalinity** (0-100 cm)					
- Ec mmhos/cm	<1	1-4	4-8	8-15	>15
- ESP (0-100 cm)	<4	4-10	10-20	20-25	>25

NF: no flooding Mod: moderate SL: sandy loam LS: loamy sand
C: clay Cm: massive clay S: sand

Internal drainage means where there is internal impendent of water flow.

FIRST SCHEDULE

regulation 6

PART 3

Soil qualities and classes for wetland rice system under natural flooding

PARAMETER	LAND CLASSES				
	I	II	III	IV	V
1. Slope	N.L.	<2%	<4%	<6%	<6%
2. Wetness - Flooding - Drainage	3 -4 months Poor	3-4 months Poor to imperfect	<2 months V. Poor to moderate	<1 month V. Poor to moderate	too short or too long V. Poor to good
3. **Physical** - surface text./structure - Subsurface text.	Cm to SiCs Cm to LSf	Cm to SCL Cm to Sc	Cm to Sf -	Cm to Sf -	Cm to Sc -
4. **Salinity/alkalinity** - Ec (mmhos/cm) - ESP (%)	<1 <4	<4 <10	<6 <20	<6 <25	<6 <25

Cm: Massive clay
Sf: Fine sand
N.L: Not limiting
SiCs: Silty clay blocky
Sc : Coarse sand
V .P.: Very Poor
SCL: Sandy clay loam
LSf: Loamy fine sand
MO months

FIRST SCHEDULE

regulation 7

PART 4

Soil qualities and classes for wetland rice under irrigated systems

PARAMETER	LAND CLASSES				
1. Slope	I <1%	II <2%	III <3%	IV <4%	V <5%
2. Wetness - Flooding - drainage	N.L. Mod. to IP	N.L. Good to poor	3-4 months Good to V.P	3-4 months -	too short or too long
3. Physical - Surface, texture, structure - Subsurface texture/structure	Cm to SiCs Cm to LSf	CM to SCL Cm to Sc	Cm to Sf -	Cm to Sf -	Cm to Sc
4. Salinity/Alkalinity - Ec (mmhos/cm) - ESP (%)	<2 <5	<4 <10	<6 <20	<6 <35	<6 <35

Cm: Massive clay
Sf: Fine sand
N.L: Not limiting
SiCs: Silty clay blocky
Sc: Coarse sand
V.P: Very Poor
SCL: Sandy clay loam
LSf: Loamy fine sand
I.P: Impermeable

FIRST SCHEDULE

regulation 3 (2) (d)

PART 5

CLASSIFICATION OF AGRICULTURAL LAND (RAIN FED AGRICULTURE)

1. Prime agricultural land, which is high value land with least management problems apart from nutrients management.
2. Good agricultural land.
3. Medium agricultural land.
4. Marginal/fragile agricultural land.
5. Low value/Unsuitable agricultural land.

FIRST SCHEDULE

regulation 9

PART 6

PARAMETERS AND METHODS OF DETERMINATION

There are a variety of soil parameters used for the management of soils:

Chemical parameters

Soil Acidity (pH)

The parameter generally denotes soil reaction which expresses the degree of "acidity" or "alkalinity". The pH value equals the negative logarithm of the H^+ ion concentration (C_{H^+}) . Conventionally, the soil pH is measured in a soil - water suspension 1:2.5 (10 g soil in 25 ml water) and is designated pH (water). It could also be determined in suspensions of 1:1 or 1:5.

For the measurement of exchange (reserve or potential) acidity of an acid soil a 1:2.5 suspension is used to which a neutral salt (KCl) has been added, in order to bring exchangeable H-ions into solution. It is designated pH (KCl). The pH values of a soil is most accurately measured with a pH meter in the laboratory.

Organic matter

Organic matter, because of its colloidal nature, contributes to the cation exchange capacity, **CEC**, and therefore the nutrient retention capability of the soil. Organic matter improves the physical characteristics of the soil through its enhancement of water permeability and retention. Soil organic matter is high in organic carbon and serves as a source of energy for soil microorganisms.

Organic carbon is commonly determined by the modified Walkley and Black method (Nelson, D.W. & Sommers, L.E.)

Sodicity (ESP)

Normal soils usually have an exchange complex that is dominated by Ca and Mg and has only minor amounts of K and Na. When excess soluble salts accumulate in such soils, Na frequently becomes the dominant cation in the soil solution, a part of the original Ca and Mg is replaced by the cation. In general, physical properties become increasingly unfavourable with increasing levels of exchangeable Na.

The commonly determined parameter is the exchangeable sodium percentage (ESP).

$$ESP = \frac{\text{Exchangeable Na (meq/100 g soil)} \times 100}{\text{Cation Exchange capacity (meq/100 g soil)}}$$

Salinity (Ec)

Saline soils contain soluble salts in concentrations that impair crop growth. Although weathering of primary minerals is the source of nearly all soluble salts, accumulation of these on the spot are seldom concentrated enough to form a saline soil. Invariably, strong salinity is found under (semi) arid climatic conditions in soils where salts from other locations have accumulated through the inflow and subsequent concentrations of salt-bearing waters. Most saline soils are characterised by a low humus content, no differentiation into horizons and very little structure.

A generally accepted parameter of salinity is the electrical conductivity (Ec) at 25°C. The Ec can be determined according to the saturated paste extract method and measured with a conductivity bridge.

Cation Exchange Capacity (CEC)

The CEC of a soil often indicates its natural fertility and its ability to supply Ca, Mg, and K for plant growth. It is also a measure of the ability of the soil to store added nutrients (fertilizers). Soils which have a low CEC cannot store large amounts of plant nutrients and must be replenished more regularly.

In the inorganic part of the soil complex only clay particles play a decisive role, since the active total internal surface of silt and sand particles in comparison to that of clay is very small. The CEC of clay depends on the type of clay mineral. The organic matter complex (the humus colloids) has a much higher CEC than clay.

The CEC of a soil is determined, in the laboratory, either in an exchange medium with

pH = 8.2 or in exchange medium with pH = 7.0. Some times the expression T value is used instead of CEC value.

Exchangeable Bases

This is restricted to the cations Ca, Mg, K, and Na. The total quantity of these four exchangeable cations (S value) can be related to the CEC value and expressed as the base saturation percentage (BSP). The individual values for exchangeable Ca, Mg, and K give certain indicators of the fertility status of the soil (Macro-nutrients). The exchangeable Na percentage (ESP) is an important criterion for sodic conditions.

Exchangeable cations are determined in the laboratory by flame photometry for K and Na, and by atomic absorption spectrophotometry (AAS) for Ca and Mg (Anderson and Ingram, 1993).

Phosphorous (P)

Compounds of P (ADP & ATP) act as energy currency in plants. Energy from photosynthesis and metabolism of carbohydrates is stored in these compounds for subsequent use in growth and reproductive processes. The role of P as a structural component of a wide variety of biochemical and seed formation are also important.

Phosphorous is commonly determined by the calorimetric method (Anderson and Ingram, 1993); Olsen for extractable P and Bray II for available P.

Calcium carbonate

The presence of $CaCO_3$ affects both the physical and chemical characteristics of a soil. High lime concentrations may not severely restrict water movement but may prevent root penetration. A high $CaCO_3$ concentration particularly in the very fine fractions brings risks of lime-induced chlorosis for many crops. The physical characteristics of calcareous soils change when they are irrigated. It is therefore a vital soil quality parameter under irrigated agriculture.

Gypsum ($CaSO_4$)

Gypsum indirectly affects soil physical properties and therefore influences permeability and infiltration rate. It improves the structure and prevents sodium saturation. A small amount of gypsum is favourable for crop growth because it serves as a source of Ca as a plant nutrient and replaces Na in the exchange complex and thus acts to preserve chemical and physical soil degradation.

PART II

Physical parameters

Texture

Soil texture refers to the particle size distribution and to particle-size groupings within specific ranges. Textural classes are defined by the relative contents of the three major soil separates, sand, silt and clay. Texture is considered as one of the most important characteristics with regard to physical soil qualities. It influences such important soil properties as soil water availability, infiltration rate, drainage, tillage conditions and capacity to retain nutrients. The effect of texture on those properties may be modified by structure, nature of clay minerals, organic matter content, and lime content.

Texture is commonly determined by the hydrometer or pipette methods in the laboratory or by the hand feel method in the field.

Structure:

Soil structure refers to the aggregation of primary soil particles (sand, silt, clay) into compound soil particles or clusters of primary particles which are separated from the adjoining aggregates by cracks or surface of weakness. Soil structure exerts a dominant influence on soil's air and moisture regime, on its hydraulic conductivity and consequently, on the root growth and (micro) biological activity that occurs within the soil. It is therefore an important factor in soil productivity and soil genesis. Structure is commonly described in the field under three criteria, namely:

- grade which refers to the distinctiveness and durability
- size of aggregate;
- shape of aggregates.

Coarse Fragments or Stoniness

Surface coarse fragments in the top 20 cm will influence tillage conditions as well as the capacity to retain nutrients and water. Coarse fragments can limit the use of agricultural implements and optimum growth of roots. Coarse fragments with a diameter between 2-75 mm are termed gravel; those between 75-250 mm are called cobbles and those more than 250 mm are called stones (Sys et al.,1991).

Coarse fragments are commonly quantified on volume or weight percentage basis.

Rooting Depth

Rooting depth is a crucial parameter in soil productivity because it determines soil reserves of water and nutrients. The relationship between rooting depth and productivity is commonly described according to law of diminishing returns. It is generally defined as the thickness of loose soil above a limiting layer (if any). Limiting layer is impermeable for roots and percolating water. Soil depth is vital for the anchoring of plants and provision of a favourable environment for plant root growth.

Soil depth parameter is commonly quantified by direct depth (length) measurements.

Water Holding Capacity (WHC) or Available Moisture Content (AMC)

This is the amount of water which a given soil horizon can store and is estimated from the difference between field capacity and the lower limit of plant available water (wilting point).

The field capacity (-1/3 bar) and wilting point (-15 bar) are commonly determined in the laboratory by the pressure plate method. The field capacity value could also be determined in the field by the ponding method.

Drainage and depth to water table

Drainage and depth to water table are vital parameters. The suitability for upland crops decreases when drainage conditions become impeded. Tree crops with a deep root system are more sensitive to poorly drained conditions than annual crops with shallower root systems. Crops like paddy rice react quite differently to drainage conditions; their suitability decreases when drainage conditions improve. For irrigated agriculture, drainage, depth to ground water table and salinity status are critical evaluation parameters.

Drainage classes are normally described in the field; depth to water table is also measured in the field.

Slope

Slope angle and length are critical parameters for the assessment of erosion potential. It also influences water movement and distribution within the soil profile.

Slope angles or percentages are determined in the field.

Infiltration

Infiltration is a very important parameter irrigated farming systems. Infiltration is the entry of water into the soil through the soil surface. The rate is dependent on the antecedent moisture, soil structure, pore sizes and their distribution. It is an important parameter in evaluating compacted (physically degraded) soils eg. degraded rangelands. Rate of water entry is generally very low in degraded areas and most of the water ends up as runoff; causing considerable soil erosion and siltation problems.

Infiltration rate is commonly determined in the field using a double cylinder infiltrometer (Bouwer, 1986).

Bulk Density

This parameter largely depends on the porosity of the soil and is commonly used to evaluate compaction. Loose and porous soils have low values while compacted or physically degraded soils have high values.

Bulk density parameter is conveniently determined by the core or clod method (Anderson and Ingram, 1993).

Total Porosity

Total porosity is the fraction of the soil mass that is occupied by the pores. The pore space is largely determined by the arrangement of the individual solid particles of the soil. The pore space in the soil is partially occupied by the liquid (water) and partly by air.

Porosity is commonly computed from the relationship between bulk density and particle density (Anderson and Ingram, 1993).

Flooding

Flooding is considered as a serious limitation for most crops apart from paddy rice. Flooding interferes with the air entry into the soil.

For paddy rice cultivation flood evaluation is based on duration and depth of flooding.

Optimal duration of flooding is 110 to 160 days; marginal situations are 90-110 days and more than 180 days. The optimal depth can be considered as 10-30 cm (Sys et al. 1991).

SECOND SCHEDULE

Soil Quality Standards for Special Cases i.e. fragile soils or peculiar soils

Acid sulphate soils (Sulfaquents):

Acid sulphate soils form when the quantity of sulphuric acid, formed by oxidation of reduced sulphur compounds, exceeds the acid neutralizing capacity of adsorbed bases and easily weatherable minerals to the extent that the pH drops below 4. Potential acid sulphate soils become acidic as a result of drainage because the reduced sulphur compound (pyrite) is very stable under anaerobic condition.

Pyritic papyrus peats are common in Uganda (eg Kabale swamps). Accumulation of ferrous monosulfide (FeS) and ferrous disulphide or pyrite (FeS_2) occur in a highly reducing environment (anoxic). This process is especially prominent in the presence of mobile iron and abundance of organic matter, and under conditions of a ready supply of sulphur.

On drainage (improved aeration) atmospheric and microbiological oxidation convert the iron sulphide into ferric oxide and sulphuric acid, resulting in an extremely acid soil reaction, with pH well below 3-5, and occasionally as low as 1.0.

Diagnostic field characteristics of (potentially) acid sulphate soils :

The following tests shall be conducted before drainage of any wetland:

- Potentially non-acid sulphate soils are those that contain sizeable quantities of neutralizing cations, mainly Ca. The presence of Ca (and Mg) carbonate should be tested using diluted HCl; the CO_2 given off will cause effervescence.
- The diluted HCl test may give rise to the characteristic odour of hydrogen sulphide, indicating the presence of sulphide in the soil.
- Bluish-black colours of fresh mineral soil may point to the presence of pyrite.
- Acid - tolerant vegetation may be indicative
- Treatment of potentially acid sulphate soils with hydrogen peroxide causes a prominent drop in pH of the soil. This decrease may well be 1-2 units lower than that which develops under natural oxidation.
- Slow oxidation by the regular exposure (drying) of the moistened soil samples (air drying) over a period of several weeks gives a fair simulation of the natural process and the resulting soil reaction (pH).

Reclamation of acid sulphate soils :

Reclamation by chemical improvement of acid sulphate soils requires 20-30 tons of lime per hectare. The cost of purchasing, transporting and application of such large quantities of lime for the reclamation exercise is high and can be justifiable only in few cases. Moreover, large quantities of lime create problems of potash and trace element deficiencies. Leaching is a better solution but no land should be flooded with the drained-off water. Additional measures to be taken include: regular applications of small amounts of lime, together with basic fertilizers (not containing sulphates) and ashes; cultivation of acid-tolerant, shallow rooting crops; mounding of land in the case of more deeply rooting crops and good water table management.

Irrigation

The soil qualities considered important for irrigation purposes are the following:

- topography (slope)
- wetness - flooding and drainage characteristics,
- physical soil characteristics :
  - texture (includes surface and subsurface)
  - soil depth,
  - salinity and alkalinity.
  - infiltration
- soil chemical characteristics

The qualities mainly relate to irrigation of crops normally grown under rain fed-conditions and give particular attention to soil-water plant relationship. These qualities are not applicable to drip irrigation. The soil chemical qualities are, per earlier recommendation, on the general threshold values for fertility management.

Five classes are proposed: suitable moderately suitable, marginally suitable, potentially suitable, and not suitable for irrigation.

It is important to note that some of the recommended parameters are normally assessed in the field i.e. some parameters have no quantitative values e.g. drainage classes, soil structure etc.

Since most water sources in Uganda are not salt affected it is assumed that the irrigation water will also be free of salts. Salt content of irrigation water is expressed in one of the : parts per million (ppm); milligrammes of salt per litre (mg/l); or as electrical capacity expressed as microOhms per centimetre ($Ec.x10^{-6}$). High calcium carbonate and gypsum levels occur in very localised areas in Uganda and hence no values are included in the paramenters specified in the First Schedule.

Class I	-	Suitable,
Class II	-	Moderately suitable,
Class III	-	Marginally suitable,
Class IV	-	Potentially suitable,
Class V	-	Unsuitable.

Wetlands Rice Systems:

The wetlands rice systems have been grouped into two broad categories:

- rice cultivation under natural flooding or waterlogged areas and,
- irrigated rice systems.

The natural flooding or waterlogged systems represents the small scale rice producers in periodically flooded alluvial plains and valleys in Tororo, Iganga, Pallisa districts etc. These systems depend on flooding from rain events. The irrigated systems represents the large scale systems where irrigation waters are "fairly" well regulated. These rice production systems are adapted to specific hydrologic conditions and specific soil qualities.

The first category is very widespread in eastern Uganda and it is the main cultivation pattern in wetlands.

The following are suitability classifications of soils for natural waterlogged rice production system based on landform, flooding and physical soil properties:

Class I - Suitable,

Class II - Moderately suitable,

Class III - Marginally suitable

Class IV - Potentially suitable,

Class V - Un suitable.

THIRD SCHEDULE

regulation 15

Suggested frequency of monitoring soil quality parameters for enforcement purposes

Soil parameter	Suggested monitoring frequency
Soil physical indicators	
Bulk density and porosity	Annually
Structure	2 years
Texture	3 years
Water holding capacity	3 years
Infiltration	Annual
Coarse fragments and stoniness	Every 5 years
Soil depth	3 - 5 years
slope, depth to water table, and drainage class	Planning phase
Soil biology indicators	
Soil organic matter	Annually
Soil chemical indicators	
pH	Annually
Exchangeable bases	2 years
P	2 years
CEC	2 years
Calcium carbonate and gypsum	Planning phase
Alkalinity, Sodicity (for irrigated agriculture)	3 to 5 years

FOURTH SCHEDULE

regulation 11

Soil Conservation Guidelines (section 31 (2) (iv) of the Statute):

Soil conservation is considered on a holistic basis as activities and techniques of environmentally sound production of food, wood, and other commodities based on sustainable use of land, species and ecosystem. In all these areas a combination of several conservation practices are recommended and packages will depend on area and crops / livestock/ tree species on the land.

Lowlands and flat areas (Slopes up to 2%)

Lowlands are the alluvial plains and the bottom lands of small tributaries in a catchment. The following soil conservation structures and practices are recommended :

- surface or subsurface drainage,
- interception and diversion ditches,
- rows of crops should be laid out at right angles to the contour lines,
- crop rotation,
- fertility improvement (package will depend on crops and area).

Diversion ditches or field ditches should be at a spacing of 100 to 200 metres; depth 30 cm and length not more than 500 metres. These should be laid out slightly off the contour to obtain a gradient of 0.3 to 0.5%. The collecting ditches (depth 60 cm), should drain into main ditches or natural drainage ways and should run in the direction of the greatest slope.

Undulating to hilly topography (Slopes of 3 to 15%)

Recommended conservation practices:

- contour cultivation
- contour ridges or absorption banks at a spacing of 30 m,
- grass strips and strip cropping; width 30 m,
- mulching,
- agroforestry,
- crop rotation and fertility improvement,
- wind breaks or shelter belts; Should be located perpendicular to main erosive wind direction.

Steep topography (Slopes 15 - 60%)

Simple conservation practices are insufficient to stop erosion and following management practices are recommended:

- terraces,
- contour cultivation (ploughing and planting along the contour), and absorption banks at a spacing of 10 - 20 m.
- crop rotation and fertility improvement,
- strip cropping - strip width 10 to 20 m)
- agroforestry.

Pasture and Rangelands

A Pasture:

- contour furrows at small distances (20 m),
- interception ditches,
- stone cordons : loose stones on the surface collected and deposited on contours,
- silt traps - built from stones or soil in small depressions,
- pasture and fertility improvement.

Additionally an optimum stocking rate is required. Areas with fertile soils and rainfall >850 mm per year - 2 cows per hectare are recommended; areas with low fertility and rainfall <850 mm per year - 1 cow per hectare is recommended. Pasture species and animal breeds are additional considerations.

Rangelands:

These recommendations are particularly targeted at the " **Cattle Corridor**" Recommendations will depend on state of rangelands.

- revegetation or reseeding - closing the area to grazing and allow natural grasses to establish or reseed with suitable species of grasses and legumes.
- gully control with mechanical barriers (dry reeds, vegetation, stones etc),
- controlled or rotational grazing;
- run off harvesting - divert and impound run off to prevent soil erosion , gully development and allow slow permeability into the soil.
- fertility improvement.
- remove low value grass and tree species to allow nutritive species to proliferate and cover bare ground.

FIFTH SCHEDULE

regulation 13 (1) (d)

- National Agricultural Research Organisation, (Kawanda);
- Makerere University (Soil Science Dept. - FAF);
- Makerere University (Chemistry Dept. - Pesticides),
- Laboratory of the Government Chemist - Pesticides),
- National Bureau of Standards - Consumer products standards.

REFERENCES

1. USDA (1962): *Soil Survey Manual.* U.S. Department of Agriculture Handbook No. 18. (Revised). US. Govt. Printing Office, Washington, D.C.

2. USDA, (1975): *Soil Taxonomy. a basic system of classification for making and interpreting soil surveys.* U.S. Department of Agriculture Handbook No. 436, US. Govt Printing Office, Washington, D.C.

3. Euroconsult, (1989): *Agricultural Compendium for rural development in tropics and subtropics (3rd Edition).* Elsevier Science Publishers, The Netherlands.

4. Soil Survey Staff, (1971): *Guide for interpreting engineering use of soils.* SCS, USDA, U.S. Govt. Printing Office, Washington, D.C. 87 pp.

5. FAO, (1977): *Guidelines for soil profile description (Revised).* Land and Water Development Division, Soil Survey and Fertility Branch, FAO, Rome.

6. U.S.D.A Department Interior. BLM, (1968): *Where not to build. a guide for open space planning.* Tech. Bull. I. Washington, D.C. 160 pp.

7. USFHA, (1973): *Engineering Soil Classification for residential development.* FHA 373.

8. Wischmeir W.H and J.V Manrering, (1969): *Relation of Soil properties to its erodibility.* Soil Sci. Soc. Amer. Proc. 33:131-137.

9. Stewart, 1975:

10. USDA, (1951): *Soil Survey Manual.* U.S. Department of Agriculture Handbook No. 18. U.S. Govt. Printing Office, Washington, D.C.

11. Klingebiel, A.A. and P.H. Montgomery, (1966): *Land Capability Classification.*

    USDA Agricultural Handbook 210.

12. The Canada Land Inventory, (1972): *Soil capability classification for agriculture.* Report No. 2.

13. Bartelli L. J., (1979): *Interpreting soil data. In: Planning the uses and Management of Land.* ASA - CSSA - SSSA. Madison, Wisconsin.

14. Tulare County Department Planning, (1975): *Rural Valley Lands Plan.* Amendment to Tulare County Area General Plan Amendment 75-1D. County of Tulare, California.;

15. Sys, C. and Riquier J., (1980): *Ratings of FAO/UNESCO soil units for specific crop production. Land resources for populations of the future.* Report of the second FAO/UNFPA expert consultation. FAO, Rome:55-95.

16. Beek, K.J., (1978): *Land evaluation of agricultural development.* ILRI Publication 23. ILRI, Wageningen.

17. Beek, K.J. and J. Bennema, (1972): *Land evaluation for agricultural land-use planning, An ecological methodology.* 61 pp (mimeograph). Department of Soil Science and Geology, Agricultural University of Wageningen, Wageningen.

18. U.S.D.A, (1980a): *Appraisal 1980 Soil and Water Resources, Conservation Act Review Draft, Part I.* Washing, D.C.

19. U.S.D.A, (1980b): *National Summary: Evaluation of Agricultural Conservation Program.* Washington, D.C.

20. Chenery, E.M., (1960): *Introduction to the Soils of Uganda Protectorate.* Series 1 - Soils. Memoir I. Ministry of Agriculture, Uganda.

21. Ollier C.D. and J.F. Harrop, (1960): *The Soils of Eastern Province.* Series 1. - Soils. Memoir 2. Ministry of Agriculture Uganda.

22. Ollier C.D., (1959): *The Soils of Northern Province (excluding) Karamoja.* Series 1 -Soils. Memoir 3. Ministry of Agriculture, Uganda.

23. Radwanski S.A., (1959): *The Soils and Land-Use of Buganda.* Series 1. Soils Memoir 4. Ministry of Agriculture, Uganda.

24. Wilson J.G., (1960): *The Soils of Karamoja District.* Series 1 - Soils. Memoir 5. Ministry of Agriculture, Uganda.

25. Harrop J.F., (1960): *The Soils of Western Province.* Sereis 1 - Soils. Memoir 6. Ministry of Agriculture, Uganda.

26. David Dent and Anthony Young (19...): *Soil Survey*

and Land Evaluation. School of Environmental Science, University of East Anglia, Norwich, George Allen and Union London.

27. David N. McMaster: *a Subsistence Crop Geography of Uganda.* Geographical publications Limited, 1962.

28. Donald a. Davidson: *The Evaluation of Land Resources.* University of Stirling, August, Co-published in the United States with John Wiley and Sons, Inc. New York, 1991.

29. John Van Nostrand Associates Limited: *Kampala Urban Study*. Final Report Part II, Structure Plan, March, 1994.

30. Nairobi Urban Study Group, 1973: *Nairobi Metropolitan Growth Strategy* Volumes I and II.

31. Lewis Keeble,: *Principles and Practice of Town and Country Planning.* London, The Estates Gazette Limited, 1976.

32. Ronald L. Doering, *et al,*: *Planning for Sustainability: Towards integrating Environmental Protection into Land-Use Planning.* a discussion paper prepared for the Royal Commission on the future of the Toronto Waterfront, June, 1991.

33. Roseable Lowia: *The Impact of Agricultural Intensification on Aquatic Ecosystems in Uganda.* Environmental Management for Developing Countries, Volume I, 1994. Institute for Scientific Cooperation, Tiibingen, Federal Republic of Germany, 1991.

34. Uganda Government: *The Local Government Act 1* 24th March, 1997.

35. Uganda Government: *The National Environment Statute, 24 May, 1995.*

The National Environment Statute, 24th May, 1995;

36. Uganda Government: *The Public Health Act, Cap 269 1964.* (Revised Edition).

37. Uganda Government: *The Town and Country Planning Act, Cap 30 (LOU)*. Revised Edition, (1964).

38. The Republic of Uganda: *The Constitution of the Republic of Uganda 1995*.

39. Jones R. Kamugisha, 1993: *Management of Natural Resources and Environment in Uganda. Policy and Legislation Land-marks.* Published by SIDA's Regional Soil Conservation Unit, RSCU, 1993.

40. Anderson, J.M. and Ingram: *Tropical Soil Biology and Fertility: a handbook of methods.* Second edition J.S.I. CAB International. Wallingford, UK., 1993.

41. Bouwer, H.: *Intake Cylinder Infiltrometer. In: Methods of soil analysis. Part I. Physical and mineralogical.* Klute a. (ed.) ASA. pp 834-843, 1986.

42. FAO: *African Agriculture: The next 25 years.* FAO. Rome, 1986.

43. FAO: *a Suggested National Soils Policy for Uganda.* FAO/UNEP Project FP/6101-88-01, 1994.

44. Foster, H.L.: *Rapid routine soil and plant analysis without automatic equipment. I. Routine Soil Analysis.* East African Agricultural and Forestry Journal 37; pp 160 - 170, 1971.

45. Lal, R.: *Tropical ecology and physical edaphology.* John Wiley and Sons, New York. 732pp, 1987.

46. Lal, R.: *Tillage effects on soil degradation, soil resilience, soil quality and sustainability.* Soil Trillage Res. 27: 1 - 8, 1993.

47. Lal, R. and F.P. Miller: *Soil Quality and its Management in Humid Sub-Tropical and Tropical Environments.* p. 1541 - 1550. In: Proc. XVIII. Intl. Grassland Congress., Feb. 13 - 16, 1993, Palmerston North, New Zealand.

48. Lal, R.: *Methods and Guidelines for Assessing Sustainable Use of Soils and Water Resources in the Tropics.* SMSS Tech. Bull. 21. USDA Soil Conservation Service, Washington, D.C. 78pp, 1994.

49. Magunda, M.K.: *Quantifying and Monitoring Soil Physical Degradation in Uganda: The challenge ahead.* Proceedings of the 14th Conference of the Soil Science Society of East Africa. (In Press), 1994.

50. Milne, G.: *Some suggested units for classification and mapping particularly for East African soils.* Soil Research 4: 183 - 198, 1935.

51. NEAP: *The National Environment Action Plan (Uganda)*. National Environment Action Plan Secretariat. Ministry of Natural Resources, 1995.

52. Nelson, D.W., and Sommers, L.E: *a Rapid and Accurate Method for Estimating Organic Carbon in Soil.* Proceedings of the Indiana Academy of Science. 84:456-462, 1975.

53. Sys, C., Van Ranst, E. and Debavaye, J.: *Land Evaluation Part I: Principles in Land Evaluation and Crop production Calculations.* ITC Ghent, Agricultural Publications No. 7, pp. 273, 1991.

54. NEAP: *Mining, Industry, Hazardous Materials and Toxic Chemicals.* Paper Vol. 6, 1993.

55. Department of Environment (Uganda): *The Hazardous Waste Inspectorate Hazardous Waste Management: An Overview.*, June 1985;

56. WHO - UNEP: *Hygienic Criteria of Drinking water quality.* Edited by Gury Krasovsky, 1986.

57. *Practical Waste Management.* Edited by John R Holmes, John Willy and Sons 1983

58. World Bank Technical Paper No. 93 (1989): *The Safe Disposal of Hazardous Waste.*

59. UNEP: *Code of Ethics on The International Trade in Chemicals.* UNEP, 1994.

60. UNEP, Report No. 1: *List of Environmentally Dangerous Chemical Substances and Processes of Global Significance.* IRPTC-Geneva (1984).

61. United States Environmental Protection Agency
Operations Branch: Chemical Management Division
Office of Pollution Prevention and Toxics
EPA, 1994 Edition;
PCB Questions and Answers.

62. Directorate of Water Development/ Ministry of Natural Resources: Uganda Water Action Plan: *Rapid Water Resources Assessment*: June 1994.

63. United Nations: *Transport of Dangerous Goods.* Sevens revised edition. New York, 1991.

64. UNEP/IEO: *Storage of Hazardous Materials: a technical guide for Safe Warehousing of Hazardous* Materials. Technical Report No. 3. UNEP, 1990.

65. Ministry of Natural Resources/Government of Uganda: *Lake Victoria Environmental Management Programme.* Report of the Working Group No. 2 on Management of Water Quality and Land Use including Wetlands (Uganda). June 1995.

66. Ministry of Natural Resources/Government of Uganda: *Lake Victoria Environmental Management Programme.* Report of the Working Group No. 2 on Management of Water Quality and Land Use including Wetlands (Kenya). June 1995.

67. Ministry of Natural Resources/Government of Uganda: *Lake Victoria Environmental Management Programme.* Report of the Working Group No. 2 on Management of Water Quality and Land Use including Wetlands (Tanzania). June 1995.

68. *Screening Information Data Set for High Production Volume Chemicals OECD Initial Assessment.* Processed by IRPTC. July 1996.

69. *European Centre for Ecotoxicology and Toxicology of Chemicals: Existing Chemicals: Literature Reviews and Evaluations.* Technical Report No. 30(5). May, 1994.

70. UNEP/UN: *Regulations and Guidelines on Chemicals.* An Extract from the IRPTC Data Bank; Volumes 1 - 3. IRPTC Legal File 1992-1993.

71. United Nations: *Consolidated List of Products Whose Consumption and/or Sale Have Been Banned, Withdrawn, Severely Restricted or not Approved by Governments.* United Nations, New York, 1994.

72. Ministry of Natural Resources (NWSC): *Water Legislation Study Extension.* Final Report, August 1995.

ANNEX I

REPORT OF THE WORKSHOP ON DEVELOPMENT AND HARMONIZATION OF ENVIRONMENTAL LAWS IN SELECTED TOPICS IN EAST AFRICA

I. INTRODUCTION

This is a synoptic outline for a workshop to discuss the development and harmonization of environmental law on selected topics in the East African Region under the UNEP/UNDP/DUTCH Joint Project on Environmental Law and Institutions in Africa. The purpose is to provide a handy brief on the objectives of the workshop. A brief background, particularly how the workshop falls into the overall picture of the Joint Project, is provided. The section on participants indicates the mode of selection and the role to be played by the individuals. That is directly related to the schedule of the workshop, which outlines the procedure for the participation of those invited.

Finally, the section on the procedure for finalization of the report is outlined.

II. BACKGROUND

The East African Sub-Regional Project is a component of the UNEP/UNDP Joint Project on Environmental Law and Institutions in Africa funded by the Dutch Government. Systematic and essentially national activities are being conducted in Burkina Faso, Malawi, Mozambique and in Sao Tome and Principe. Although South Africa was identified by the Project Steering Committee as a project country, no systematic activities have been done there and no firm decision has been taken by the Government as to whether they will, in fact, be so involved. This uncertainty is occasioned by the broad constitutional, policy and legislative reorientations which have been evolving in the country since 1994.

The activities of the Joint Project in East Africa (Kenya, Tanzania and Uganda) focus on mattes of sub-regional character. The underlying presupposition is that the physical and historical situation in East Africa offered an opportunity to initiate and encourage dealing with environmental issues according to problem-sheds. The historical facts are that (a) there is a history of regional cooperation among the countries from colonial times; and (b) there is shared legal tradition which derives from common law origins. It was resolved by the Project Steering Committee that the two historical facts could be relied upon to support harmonized legislation on selected themes in the commonly shared environment.

Representatives of the three governments met in February 1995 to work out general principles and modalities for their cooperation. Their second meeting was in May 1995 to discuss the general terrain of topics amenable to development and harmonization of laws. The final decision on six priority topics was taken at their third meeting in February 1996.

The six topics which were selected for the Project's activities are: (i) Development and harmonization of EIA Regulations; (ii) Development and harmonization of laws relating to transboundary movement of hazardous wastes; (iii) Development and harmonization of the methodologies for the development of environmental standards; (iv) Development and harmonization of forestry laws; (v) Development and harmonization of wildlife laws; and (vi) Recommendation for legal and institutional framework for the protection of the environment of Lake Victoria. For each of the topics, the delegates worked out generic terms of reference. However, each national team was subsequently to work out country-specific terms of reference to reflect national legal and institutional situations as well as existing priorities.

The respective national consultants were also selected by the National Coordinating Committees (NCC), working in consultation with an officer at the UNDP country office.

The national consultants have now completed their work. In each case, the reports have enjoyed review by the national panels constituted under the aegis of the respective NCCs. Draft reports, as they evolved, were circulated to the consultants in the three countries. In some cases, the consultants were able to take the reports of their counterparts into account in finalizing their reports. Therefore, some degree of harmonization of reports will, presumably, have been done.

The workshop which is proposed herein, will bring together the consultants for each topic for substantive discussions of their reports and to agree on recommendations as to what should be done next and by whom.

III. OBJECTIVES

The objectives of the workshop may be summarized as follows:

(1) to ensure that the recommendations for policies and law for the respective topics are in harmony as far as possible;

(2) to promote the development of legal and institutional machineries which are comparable in all the three East African countries in the absence of an over-arching sub-regional framework;

(3) to harmonize the normative prescriptions and institutional machineries and therefore create an opportunity for harmonized enforcement procedures; and

(4) to create an opportunity for dealing with the respective environmental problems according to the problem-sheds, which are essentially sub-regional.

(5) to make recommendations on how each country should proceed towards implementation of the recommendations.

IV. PARTICIPANTS

There will be four (4) broad categories of participants, over a seven days period:

(1) Consultants who worked on each respective topic. These will work as specific sub-regional teams of experts of reach topic and the number per topic varies by the subject and from country to country. The selection of consultants was done so as to ensure complementarity of expertise and, therefore, full coverage of the topic.

A list of consultants by the topics is attached.

(2) National Coordinators for the project will attend from each of the three countries. Since they are in the picture of the project and how the consultancies were carried out at the national level, the coordinators will attend throughout the workshop. They are to carry the national spirit and ownership, ensuring that the workshop recommendations are consistent with national legislative procedures and policies. They can therefore suggest adjustment in the recommendations while maintaining the overall objectives.

The meeting of country representatives in February 1995 had suggested that the national coordinator, who would eventually attend this workshop, should ideally have legal training. However, where the coordinator has no legal training then he/she should be accompanied to this workshop by another government officer who is fully aware of this project and is legally trained.

The rationale for this position is that the coordinator (and such an associate) would be responsible for ensuring that the documents emanating from the workshop are consistent with the national legislative framework, procedures and policies.

This provision should explain instances where the one national coordinator may be accompanied by an additional officer. The national coordinator and his/her associate would also have two procedural functions at the workshop. First, they would be advisors to the meeting of permanent secretaries (see below) on the substance and procedures of the project. Secondly, they will present the status report on the evolution of the project at country level, to the meeting of permanent secretaries.

(3) There will be two principal Facilitators at the Workshop. The two persons will have read all the six reports from the three countries and identified the main features/typologies which require (i) improvement for internal cogency and/or (ii) harmonization from normative, procedural or institutional point of view.

It is proposed here that while the foregoing preparation should ideally cover all the six topics from the three countries, it may be practical for the respective facilitator to read broadly, but prepare detailed comments on only three topics. We anticipate that two teams of respective consultants on each topic will run concurrently for a maximum of two days for each topic, making a total of three days for the consultants' sessions. Thus, a facilitator would work in details with one group on three teams for the respective three days.

The East African Sub-Regional Project has been an intriguing experiment not only for the project management but also for members of the Steering Committee. The latter group is keen to follow the procedure and see the quality of the outcome. For these reasons, the project management has deemed it fit that the facilitators for each team of consultants should be from the institutions and members of the Steering Committee.

It is with gratitude we record here that Professor David Freestone (The World Bank) and Mr. Jonathan Lindsay (FAO) have accepted to assist as facilitators for the workshop.

(4) A meeting for Permanent/Principal Secretaries responsible for environment from the three countries, was proposed by the 1995 meeting, as a component of the sub-regional workshop. Therefore, there would be only one such officer from each of the three countries, making a total of three.

Their meeting will be attended by the national coordinators as discussed above.

The permanent/principal secretaries are the accounting officers and policy leaders in their ministries. It was deemed essential that they receive a full briefing on the aspirations and activities of the project. In this way they can discuss the deliverables and take decisions and assume actual ownership of the outcome.

Ultimately, their cooperation and support is essential for the national level adoption and enactment of the recommendations of this project.

This explains the necessity of a meeting of these senior officers together with their national coordinators, with pertinent legal backing. It is also essential that this meeting be held towards the end of the workshop, to receive the report or outcome of the sessions of consultants.

The meeting will comprise a briefing on the overall Joint Project by the management, and a report on the national activities by each of the three coordinators; workshop reports from the meeting of consultants on each of the project topics, given by the national coordinators. In other words, each national coordinator will assume the repertory role for two of the six topics.

(5) The overall workshop Chair will be by Director, UNEP Environmental Law and Institutions, Programme Activity Centre.

V. PROGRAMME OF THE WORKSHOP

The Workshop will be divided into two broad categories:

1. Meeting of Experts/Consultants

2. Meeting of Permanent/Principal Secretaries

The duration is from 2nd to 10th February 1998. The daily schedule will be from 0830 hours to 1700 hours, subject to variation by necessity.

Although the records of the proceedings will be kept by the Secretariat, it is proposed that a representative/consultant from one of the countries be the official rapporteur, responsible to the workshops, for the accuracy of the reports. Subject to confirmation by the meeting of consultants, we propose that the country teams be designated as rapporteurs as follows: EIA Regulations (Uganda); Lake Victoria Environment (Tanzania); Hazardous Wastes (Tanzania); Environmental Standards (Uganda); Wildlife (Kenya); and Forestry (Kenya).

Daily meetings of the experts will run on two Tracks, as below:

Dates	**Track I in Topics**	**Track II Topics**
2nd & 3rd February	EIA Regulations	Lake Victoria Environment
4th & 5th February	Hazardous Wastes	Wildlife Legislation
6th & 7th February	Environmental Standards	Forestry Legislation

Consultants for each topic will arrive the day before their respective topics schedules on the programme and depart after the end of the second day. The Coordinators as described above will stay from 1st to 10th February 1998.

8th February
- Preparation of reports by the Coordinators
- Arrival of Principal/Permanent Secretaries

9th and 10th February
- Meeting of the Permanent/Principal Secretaries (with Facilitators from FAO and The World Bank and the National Coordinators). The six topics will be paced out over the two days and resolution adopted at the end of the deliberations. A detailed programme of work for the two days will be drawn in consultations with the national coordinators.

VI. OUTLOOK

At the end of the meeting of the experts, each consultant will be expected to have a clear picture of what additional amendments or changes they need to do to effect the harmonization. It will be urged that such amendments are completed within approximately two weeks after the workshop.

Secondly, the national coordinators will advise on the approximate schedule for the national consensus-building workshops and implementation of recommendations.

Finally, the consultants will make such other adjustments as may be recommended by the workshop. The national coordinators will advise on when the final reports will be submitted and, therefore, the activities concluded.

The principal/permanent secretaries may, in instances where they deem it practical, advise on when the legislative actions might be taken at national level on each topic.

UNITED NATIONS

United Nations Environment Programme

Distribution: RESTRICTED
UNEP/UNDP/Joint Project

East Africa Sub-Project
20 April 1998

ORIGINAL: ENGLISH

UNEP/UNDP JOINT PROJECT ON ENVIRONMENTAL LAW AND INSTITUTIONS IN AFRICA

EAST AFRICAN SUB-REGIONAL PROJECT MEETING OF THE PERMANENT SECRETARIES RESPONSIBLE FOR ENVIRONMENTAL MATTERS

Nairobi, 15 April 1998

REPORT OF THE MEETING OF THE PERMANENT SECRETARIES ON THE DEVELOPMENT AND HARMONIZATION OF ENVIRONMENTAL LAW ON SELECTED TOPICS UNDER THE EAST AFRICAN SUB-REGIONAL PROJECT

Background:

1. The meeting of the Permanent Secretaries responsible for environmental matters in Kenya, Uganda and Tanzania met in Nairobi, Kenya at the UNEP Headquarters on 15 April 1998. The meeting marked a culmination of series of activities executed under the East African Sub-regional Project of the UNEP/UNDP/Dutch Joint Project on Environmental Law and Institutions in Africa which began in 1995. In particular, the Permanent Secretaries met to discuss, evaluate and assess the recommendations made by a series of six sub-workshops held simultaneously and back to back in Kisumu, Kenya from 2-10 February 1998.

II. The sub-workshops had reviewed and assessed the reports prepared by national consultants on the six priority areas identified earlier on, namely, Environmental Impact Assessment (EIA) Regulations, Hazardous Wastes, Environmental Standards, Lake Victoria Environment, Wildlife laws and Forestry laws. Furthermore, each sub-workshop had made a series of recommendations geared towards assisting the national consultants with mechanisms to strengthen their reports on the basis of discussions and comments made in the relevant sub-workshops.

III. Based on recommendations made by experts in the six sub-workshops, the meeting of Permanent Secretaries was convened as above stated to review the work of the experts and the recommendations for action. The one day meeting was followed by another day's meeting of the National Coordinators of the Project to finalize the documents, on the basis of instructions given by the Permanent Secretaries.

OPENING OF THE MEETING:

IV. The meeting of the Permanent Secretaries was officially opened by Mr. Donald Kaniaru, Director, UNEP, ELI/PAC, at 9.10 a.m. on 15 April 1998 at UNEP Headquarters. The morning part of the meeting was chaired by Mr. Donald Kaniaru, while the latter afternoon part was chaired by Mr. Patrick Kahangire, Acting Permanent Secretary, Ministry of Natural Resources, Uganda.

V. In his opening remarks, Mr. Kaniaru expressed his hope that the intervening period had provided appropriate opportunities to the Permanent Secretaries to be briefed on the results of the sub-workshops by their National Coordinators, and that in turn, they had consulted their other colleagues in the relevant Government departments on the issues discussed. In that regard, he called upon the Permanent Secretaries to comment on each of the six areas, principally focusing on updates and actions taken since the sub-workshops in February 1998. He further requested them to endorse or modify or add to the recommendations or specific points made by the consultants to pave the way for targeted implementation.

VI. He concluded by urging that the three Governments should advise the relevant departments dealing with the East African Co-operation Secretariat (EAC) of the evolving need to take up environmental policy coordination questions urgently, and the possibility of negotiating treaties or protocols to give legal effect to the recommendations made by the consultants. He assured the Permanent Secretaries that once EAC is advised by the Governments, UNEP would be ready to assist by making its expertise available to the EAC and the Governments.

BRIEF ON THE SCOPE OF THE JOINT PROJECT:

The Task Manager of the UNEP/UNDP Joint Project in Environmental Law and Institutions in Africa, Professor Charles O. Okidi, briefed the Permanent Secretaries on the scope, objective and status of the Joint Project including the sub-regional project. He clearly showed them what the Sub-Regional Project has achieved to date and where it stands in relation to the overall Joint Project.

STATEMENTS BY PERMANENT SECRETARIES:

The Permanent Secretaries made statements and, in particular, informed the other participants the role the Joint Project has played in their countries, in particular, in the field of the development of environmental law and institutions including building the capacities of their officials and institutions. Status of development of environmental legislation in each country were narrated in the statements including the constraints faced in the implementation of some of the activities.

The Permanent Secretaries appreciated the Joint Project efforts in organizing several capacity building workshops in the field of environmental law. They were also delighted with the efforts taken by the Project to utilize national experts to undertake review of the six priority areas. The exercise has succeeded in building a cadre of national expertise in the field of environmental law and ensures national ownership of the reports produced and laws and/or implementing regulations prepared.

VII. All of them were thankful to the sponsor of the Joint Project, the Dutch Government, the implementors of the Project, UNEP and UNDP as well as all other supporting partner organizations, IUCN, FAO, and the World Bank. To this end, they unanimously recommended the extension of the Joint Project to permit them to complete the on-going activities and allow the Governments to develop regulations to implement the six areas. They emphasized that the extended period would equally permit them to focus on new priority areas identified by their experts.

PRESENTATION OF THE REPORTS OF THE SUB-WORKSHOPS:

VIII. On behalf of the National Coordinator from Tanzania, the National Coordinators from Kenya and Uganda officially presented to the Permanent Secretaries the reports which were adopted by the experts of each Sub-Workshop on the six areas discussed during their meetings held in Kisumu, Kenya from 2 to 10 February 1998. The presentation of each report was followed by discussion of the issues raised and recommendations made. As necessary, an update of the facts

or situation since February 1998 in each country was made. For instance, Uganda reported that they had their national consensus building workshop to review the reports and the revised reports have already been forwarded to UNEP. Kenya reported that it was going to hold its national workshop from 26 April to 1 May 1998 to review the consultants' reports and recommendations. Tanzania on the other hand, reported that it held its national workshop on 11 April 1998 whereby the reports were reviewed and recommendations made. As the result of the national workshop recommendations, Tanzania had requested for extension of time to permit the consultant to prepare the report on EIA while the one dealing with the forestry legislation to rewrite it to the required standards.

IX. The reports presented were on the development and harmonization on the following six areas:-

(i) Environmental Impact Assessment Regulations

(ii) Forestry Legislation

(iii) Transboundary Movement of Hazardous Wastes

(iv) Methodology for the Development of Environmental Standards

(v) Management of the Lake Victoria Environment

(vi) Wildlife Legislation.

X. The presentation of each report was divided into four main sectors. They were namely:-

(i) General overview of the reports as presented by the national consultants in the sub-workshop.

(ii) Reasons justifying the need for sub-regional harmonization of each area presented.

(iii) Common elements to be considered by Governments during the preparation of national legislation in each of the six areas.

(iv) Conclusions made by each sub-workshop, namely, requesting EAC to assist in the preparation of an overarching agreement on the environment with sectoral Protocols on each of the six areas. While requesting UNEP to facilitate the development of the agreement and the protocols, reports urged the donor to favourably consider extending the Joint Project.

RECOMMENDATIONS:

XI. The Permanent Secretaries endorsed all the six reports of the sub-workshops together with the recommendations made with minor adjustments. They all acknowledged that the reports were a clear testimony of success of the capacity which the Joint Project has built in their countries during the execution of Joint Project activities. They expressed satisfaction with the good quality of the reports which were presented to them. While they agreed that the Joint Project has succeeded in organizing capacity building in a number of areas in environmental management, they recommended more training programmes to include the private sector. Of priority importance, the Permanent Secretaries emphasized a training programme on EIA for the private sector.

XII. While requesting UNEP to assist in the implementation of all the recommendations made, the Permanent Secretaries promised to commit themselves to support implementation of activities at national level. In addition, they promised to ensure that the recommendations they have adopted are forwarded to the EAC for implementation as proposed. They recognized the need for an overarching treaty/protocol on the environment which will facilitate future development of sectoral protocols on different priority areas. To this end, they requested UNEP to facilitate and support EAC and the Governments in the development of the proposed protocols, at appropriate moments.

XIII. To synthesize their endorsement of the recommendations made by their experts, the Permanent Secretaries requested UNEP to assist and support them in the preparation of a Memorandum of Understanding (MOU) on Environment as a matter of urgency. Consequently, the Permanent Secretaries mandated and instructed their National Coordinators to commence preparation of the draft MOU for their consideration. After consultation, the meeting agreed that the first meeting of the National Legal Experts under the sub-regional project will be held from 25 to 26 May 1998 to discuss and review the draft text which would have by then been prepared and circulated to the national experts for their input. The Permanent Secretaries expects the text to be ready for adoption at the latest in July 1998.

NXIV. Furthermore, as recommended by the experts, the Permanent Secretaries strongly requested the extension of the Joint Project to allow them to complete the activities already under way. Extension would also permit Governments to strengthen and reinforce the completed activities by developing implementing regulations. They hope that the extended period would equally permit them to focus on new priority areas to be identified.

FOLLOW UP:

XV. The Permanent Secretaries instructed the National Coordinators who met for another extra day on 16 April 1998, to finalize and compile documents discussed in their meeting.

They were instructed to prepare the following from the recommendations of the experts on the six areas which had been endorsed and the new recommendations which emanated from the meeting:-

(i) To identify from the reports of the Sub-Workshops recommendations which cut across and common to all the six areas and those recommendations specific only to certain areas. The identification of these issues are attached as *Annex IV.*

(ii) To identify recommendations which are addressed to Governments for their implementation. These are attached as *Annex V.*

(iii) To identify recommendations addressed specifically to EAC for their action and execution. These are enclosed as *Annex VI.*

(iv) To identify those recommendations which requested the support and assistance of UNEP and its affiliates in their implementation. These are enclosed as *Annex VII.*

(v) To prepare for their adoption and signature, by July 1998, a MOU on Environment. MOU, they emphasized, will be benchmark for the success of the activities under the East African Sub-project.

CLOSING REMARKS:

XVI. After usual exchange of courtesies and appreciations for the cordial and friendly atmosphere, the meeting was declared closed at 18.00 hours on 15 April 1998.

RECOMMENDATIONS ON THE HARMONISATION OF ISSUES FOR THE DEVELOPMENT OF ENVIRONMENTAL STANDARDS REGULATIONS

The three reports of Kenya, Tanzania and Uganda were harmonized and the following are the major themes for the development of environmental standards.

1. Standards are legal requirements designed to be enforced. Therefore the ideal framework for standard setting will be regulations within a framework environmental law. The use of regulations enables more expeditious review and amendment to keep abreast of technological developments.

2. The regulations should be cross-referenced to the provisions in related regulations and other sectors/laws/functions.

3. The regulation or the enabling law should include the following elements:

    - Legal definition of "Standard".
    - Consistent use of internationally recognized terminology.
    - Consistency with internationally acceptable units.
    - Consistent sampling, preservation and analytical methods.
    - Comparable systems of data collection and access methods.
    - Unrestricted access to environmental data and information, subject to proprietary interests. Where such information has been classified for purposes of national security, consideration should be given to early review for declassification in the interest of international and sub-regional cooperation.
    - A comparable institutional framework under the responsibility of the over-arching national environmental agency. The over-arching agency should have the responsibility and power to coordinate work on environmental standards nationally and sub-regionally utilizing, where appropriate, national expertise on standard setting in accordance with national procedures.
    - Enforcement of standards should be the primary responsibility of the various lead agencies under the supervision of the over-arching national environmental agency.
    - Standards should be developed in consultation with all relevant stakeholders including local communities, NGOs and the private sector.
    - Standards should represent minimum requirements but should not preclude the application of additional requirements, after EIA has been carried out, to reflect the sensitivity of certain environments.
    - The regulations should incorporate time limits for the performance of various administrative duties.
    - The regulations should facilitate the use of social and economic instruments, possibly on a sub-regional basis.
    - Provision should be made for review of administrative decisions by an independent tribunal.
    - Provision for the registration of accredited professionals who can be engaged as experts.
    - Penalties should be comparable among the three countries and their severity should be commensurate with the environmental impacts caused, but should increase for repeated and persistent offenders and may include imprisonment.

- Provision should be made for penalties to be increased to reflect inflation and other factors (for example by the use of "fine units").

- Provision for reciprocal enforcement of administrative orders (for example restoration orders) and judicial penalties. This may require a sub-regional treaty framework.

- Provision for regular review and updating of standards and the introduction of new standards.

4. The enactment of framework environmental laws in Kenya and Tanzania should be treated as a matter of urgency.

5. The formation of a Joint Committee on the development of environmental standards under the auspices of EAC

6. The allocation of a budget to facilitate the activities of the national coordinating agency for environmental standards.

7. Seek the assistance of UNEP, UNDP, the Dutch Government and other donors in facilitating the development and harmonization of national regulations on environmental standards for each of the three countries.

8. Seek the assistance of the same bodies in facilitating the harmonization of the draft standards for air, soil and water.

9. Kenya and Tanzania submit the draft standards produced by the consultants to their competent organs for consideration for development into legal standards.

10. The residents of the three East African States be given the right of access to each States' judicial and administrative systems to seek remedies for environmental damage caused by transboundary activities in violation of the agreed standards. This issue should be handled or addressed in a protocol or Memorandum of Understanding among the three countries.

11. That a protocol for co-operation and collaboration in the development of environmental standards be adopted by the three countries. This would recognize that one of the areas of co-operation identified by the Tripartite Commission for Co-operation between the three countries is environmental management and, further, that Article 124 of the 1994 Treaty Establishing the Common Market for Eastern and Southern Africa (COMESA) (to which all the three countries are parties) specifically requires the member states to co-operate in the management of the environment by taking measures to control transboundary air and water pollution arising from activities within their territories.

12. Make an individual and/or joint request to the secretariat of EAC through the appropriate national channels to assist with the implementation of the appropriate proposals of the workshop.

UNEP/UNDP/DUTCH JOINT PROJECT ON ENVIRONMENTAL LAW AND INSTITUTIONS IN AFRICA EAST AFRICAN SUB-REGIONAL PROJECT WORKSHOP ON HARMONIZATION OF DRAFT REPORTS AND LAWS

February 2-10 1998

List of Participants by Subjects

Senior Government Officials

Permanent Secretary, Ministry of Environment and Natural Resources, Kenya
Principal Secretary, Office of the President, Tanzania
Permanent Secretary, Ministry of Natural Resources, Uganda

Coordinators

Ms. Joyce Onyango	-	Kenya
Ms. Verdiana Macha*	-	Tanzania
Mr. Robert Wabunoha	-	Uganda

Consultants

Development of Forest Legislation

Prof. J.B. Ojwang	-	Kenya
Mr. Alinikisa A. Mafwenga	-	Tanzania
Ms. Jane Anywar	-	Uganda
Mr. Emmanuel Kasimbazi	-	Uganda

Development of Wildlife Legislation

Mr. Caroli Omondi	-	Kenya
Mr. R.V. Makaramba	-	Tanzania
Ms. Jane Anywar	-	Uganda

Development of EIA Regulations

Dr. Albert Mumma	-	Kenya
Mr. F.M. Werema	-	Tanzania
Mr. M.J.T. Ngalo	-	Tanzania
Mr. John Ntambirweki	-	Uganda

Development of Hazardous Waste and Chemicals Regulations

Prof. Shem O. Wandiga	-	Kenya
Mr. Justry P.L. Nyaberi	-	Kenya
Mr. C.W.A. Tenga	-	Tanzania
Mr. J. Ntambirweki	-	Uganda

Development of Environmental Standards

Dr. Francis Situma	-	Kenya
Mr. E.L. Songole	-	Kenya
Mr. F.K. Njuguna	-	Kenya
Ms. M.A. Abira	-	Kenya
Mr. V.D. Shauri	-	Tanzania
Mr. S.A. Mapande	-	Tanzania
Mr. L.S. Kinabo	-	Tanzania
Mr. C. Kyamanywa	-	Uganda
Dr. D.A. Ogaram	-	Uganda
Dr. J. Aniku	-	Uganda
Dr. M.K. Magunda	-	Uganda

** Coordinator and Consultant*

Legal and Institutional Aspects of the LVEMP

Mr. B.P. Kubo	-	Kenya
Dr. M.J. Ntiba	-	Kenya
Ms. V.N Macha*	-	Tanzania
Mr. Phidel Mwindunda	-	Tanzania
Eng. Enoch M. Dribidu	-	Uganda
Mr. Emmanuel Kasimbazi	-	Uganda

UNEP
Prof. C.O. Okidi, Task Manager
UNEP/UNDP/Dutch Joint Project on
Environmental Law and Institutions in Africa
UNEP, NAIROBI, KENYA.
Ms. Elizabeth Mrema
UNEP ELI/PAC
NAIROBI, KENYA.

Facilitators
Mr. Jonathan M. Lindsay
Development Law Service, FAO
ROME, ITALY.
Professor David Freestone
THE WORLD BANK.

ISBN-92-807-1804-1