Management of Water and Wastewater in Industries and Small Scale Enterprises

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PREFACE

The following desk study has been carried out as part of the preparation for Sida's strategy on water supply & sanitation and industrial water and wastewater management.

Two other studies have been made for water and wastewater management in large to medium-sized urban centres and on-site sanitation and small scale water supply.

The authors are solely responsible for the analysis, conclusions and recommendations in this report.

We hope that this report will be found interesting and perhaps further explain some of the guiding principles put forward in Sida's strategy for water and sanitation.

Stockholm in May 2001,

Pelle Persson

Head of the Division for Urban Development and Environment

INEC/Sida

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Introduction

Water resources are being depleted and contaminated due to wasteful usage and pollution. Pollution from industries and small-scale enterprises is one source that is becoming an growing threat to water resources in the developing world as industrialisation and urbanisation increase.

The following desk study has been carried out as part of the preparation for Sida's strategy on water and sanitation. The topic of the present report can be incorporated within two broader focus areas:

1. Water and sanitation

2. Environmental Management at industries

Although the main focus and task has been to integrate the study with the first category, many findings are by necessity applicable to industrial environmental management in general. Chapters addressing environmental legislation, Environmental Management Systems, public participation for example will of course to a large extent be applicable to air pollution and solid waste as well.

We therefore hope that this report will prove useful in designing and implementing projects in the field of water management as well as environmental management at industries.

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1. Integrated approach to water management

The problems, approaches and strategies pertaining to water and wastewater management in industries presented in this report is one aspect of water resources management.

The industrial sector- which both a user and polluter of water – is linked to other sectors and end users and the industrial water aspects should be addressed in that context.

The development of a sustainable solution should be sought from the point of view of the end users, ambient environment and water quality management. This approach would require a broader perspective including:

- Water pollution from other sectors such as municipal sewage, solid waste and non-point sources
- Competition with other end-user including domestic water supply, agricultural sector etc.

Based on these objectives a strategy encompassing all relevant sectors including both use and protection of water resources should be defined in an integrated water management approach. This strategy should take on an integrated approach including aspects such as:

- Promotion of social development
- Demand management of water for consumption and production purposes
- Protection of eco-systems
- Equitable distribution and utilisation of the water resources for different segments of society

2 Introduction to industrial activities

Water scarcity is an increasingly serious problem in many developing countries. Therefore, management of existing water resources and promotion of water rationing programmes are vital to ensure adequate water resources exist for citizens. In this context, it is necessary to introduce water conservation actions focusing on industries and small scale manufacturing businesses, which increase in number and volume and thus becomes a growing threat to water resources.

The effects on water resources due to uncontrolled industrial activities are often twofold:

1. Excessive use of water resources. Industries in many developing countries use water from their own wells without any control by the authorities concerned.

2. Pollution of both groundwater and surface water resources as a result of inadequate treatment (or no treatment at all) of industrial discharges.

Water in industry is used for cooling, transportation and washing, as a solvent, and also sometimes entering the composition of the finished product. The volumes of industrial water withdrawal are quite different within individual branches of industry and also within different kinds of production, depending on the technology of the manufacturing process.

An assessment of current withdrawal and consumption of water in different sectors and continents was made by UNESCO. According to this study agriculture is the main water consumer world-wide and receives 67% of total water withdrawal and accounts for 86% of consumption. However, in future, the proportion of water used for agriculture is likely to decrease slightly, mainly at the expense of more intensive growth in other water demands such as industry and public water supply. In summary, agriculture is expected to increase demands by 1.3, industry by 1.5 and global public supply by 1.8 times.

The proportion for water consumption in the industrial sector varies with the level of industrialisation. In Asia, Africa and South America, it is agriculture which plays the leading role in the pattern of water use. In 1995 irrigation took 60–82% of total water withdrawal and accounted for 64–92% of total water consumption. These indices will also change slightly by 2025 although by that time industrial water consumption is expected to grow two or three times in these three continents. Nevertheless, the fraction of industry concerned in total water withdrawal is not expected to be above 20% in South America, 13% in Asia and 6% in Africa.

The characteristics of industrial effluents differ from those of municipal sewage and between different industrial sectors. One key difference is whether the effluents contains heavy metals and/or non-biodegradable organic pollutants which can not be removed in a conventional biological treatment of a municipal wastewater plant. (An overview of specific pollutants for different industries is presented in chapter 3.1.) These pollutants will furthermore generate hazardous solid waste when removed by physical-chemical methods in a treatment plant. The economic and environmental aspects of the disposal of this waste must then be considered (see for example tanning industries in annex 1). As outlined in chapter 3.4 the possibility of pollution abatement through cleaner production rather than end-of-pipe solutions must therefore always be considered.

Energy and water management in Industry are both based on the principles of monitoring and targeting, in which energy and water consumption is measured and considered in relation to production figures. The concept of cleaner production also take other aspects such as energy consumption into consideration. Some types of effluent treatment are energy consuming and this should be taken into consideration from both economic and environmental point of view when designing solutions for wastewater management.

The specific problems encountered in the industrial sector will also to a certain extent depend on the type of industrial activity. The industrial set-ups in a developing country can be broadly defined within the following four categories:

- Workshops and small scale industries/enterprises within urban centres. In this category are found small workshops such as garages, recovery of lead batteries, metal plating and surface finishing industries, recovery of petroleum products and other industrial activities usually without any pollution control facilities.
- Medium to large scale industries within cities. Tanneries, food processing industries and textile dying enterprises are representatives of this category.
- Large scale industries outside cities. Heavy polluters such as smelters, cement plants, refineries and pulp and paper mills are often located outside the cities.
- Clusters of small to medium scale industries (Industrial Parks). In many countries small and medium sized industries are located in special industrial areas outside the city centres. In some cases Common Wastewater Treatment Plants (CWTP) have been built exclusively for these areas. However, often certain industries within one cluster, discharges sewage water not suitable for collective treatment.

The different categories require different technical, regulatory and institutional approaches to address the problems of sustainable water management. There are also obvious differences in the links to management of sewage from cities. The management of water resources and pollution prevention in the industrial sector differs in some important aspects from water supply and sewage.

Water supply and distribution as well as sewerage systems generally remain the overall responsibility of municipalities/public sector (although with possible involvement of the private sector) and the water consumers are the basis (or should be the basis) for a sustainable financing of the system. However, industrial establishments many times rely upon water supply based on groundwater abstracted from own wells without any restrictions. Thus, major incentives for water conservation measures are lacking and could be considered as one of the most urgent problems to solve. Also surface water supply occurs if the resource is available. Analogous to that, wastewater discharge many times is directed to the nearest watercourse or lake (by own pipes) or is just discharged to the ground outside the factory.

In the industrial sector the management and financing of environmental protection rests with the owners of the enterprises (either private or public owners), while the governmental institutions (municipal, regional and national) have a regulatory role and are generally not a provider of technical services.

With the overall responsibilities within the industrial sector and with commercial driving forces in place there are also specific possibilities to be taken into consideration when analysing possible incentives/ disincentives:

- Environmental requirements associated with export of products
- Win-win options such as cost saving through cleaner production
- Environmental certification and auditing
- Taxes, fees and other economic incentives

3. Technical and environmental aspects of water management within the industrial sector

3.1 Water pollution from industries and small scale enterprises

The main pollution problems associated with small industrial activities originate in generally from:

- Lack of environmental knowledge and awareness
- Insufficient access to information regarding Cleaner Production/Waste Minimisation techniques in small scale industries
- Inadequate knowledge of low cost pollution prevention possibilities and constraints
- Deficient insight into the features of a very basic environmental management system
- The lack of an efficient environmental monitoring system

The following rough outline of the categories of wastewater could be done:

Food Processing Industries

Wastewater from dairies is suitable for combined treatment with municipal wastewater but requires many times pre-treatment in the form of equalising and pH-adjustment. The organic load is high (often very high) and considerable amounts of phosphorous and nitrogen occur. Toxic properties are mainly connected with disinfecting and cleaning compounds. Also organic solvents (VOC emission) are used, for example in the edible oil production.

Tanning and Leather Finishing Industries

Tanneries are, together with the textile facilities, one of the most chemical intensive branches. The main threat are pesticides, chromium, bactericides, sulphide but also persistent and biocumulating substances occur. The following rough listing shows the main ingredients.

- Acids (organic and inorganic)
- Bases
- Salts (inorganic and organic)
- Ammonium
- Sodium sulphide
- Chromium
- Oils and fats
- Dyestuffs
- Organic solvents
- Enzymes
- Surfactants
- Complexing agents

This kind of wastewater always requires pre-treatment consisting of screening, manganese catalyst sulphide oxidation, chromium precipitation and removal and equalising. After pre-treatment the water is suitable for combined treatment with municipal wastewater but could also be treated in-plant (activated sludge or similar).

Textile mills (integrated or dying and bleaching)

Due to a massive and sometimes excessive use of chemicals in the bleaching and dying processes the resulting wastewater is a very complex mixture of a broad variety of chemicals. The following main classification in different types of chemicals is valid for an integrated textile mill

Basic chemicals
- Acids
- Bases
- Salts
- Organic solvents
- Oxidising agents
- Reduction agents

Surfactants
- Cationic
- Anionic
- Nonionic
- Mixed

Auxiliary dying chemicals
- Carrier
- Finishing agents
- Complexing agents

Auxiliary printing chemicals
- Thickening agents
- Bonding agents
- Finishing compounds
- Starch and cellulose derivate
- Addition polymer
- Condensable resins
- Softeners and antistatic agents
- Flame retardants and fire proof agents
- Anti-mildew agents

Chemicals of certain interest are of course halogenated organic compounds used as carriers, mercury and cadmium containing compounds, benzidine-based azo-dyes (should not be used at all), dyes found to be containing PCBs (e.g. certain sources of Cu-phtalocyanine and should be substituted immediately) sodium hypochlorite, alkyl-phenolethoxylates, metal complex dyes, complexing agents etc.

Metal plating and finishing industries

Wastewater from metal plating and finishing industries should be considered as one of the most harmful effluent due to its environmental impact. This is in particular valid for toxic metals (cadmium, lead, chromium, nickel, copper, silver, tin, zinc, etc.) which will remain forever in the ecosystem. In addition to that, the wastewater contains other hazardous components such as cyanide, oil and grease, complexing agents, fluorides, organic solvents, degreasing compounds (detergents, emulsifiers, dispersants, etc).

The wastewater could be high or low in pH-value and contains
Heavy metals
Hexavalent chromium
Metal cyanides
Unbound cyanides
Oil and grease
Volatile halogenated compounds (VOX)
Complexing agents (EDTA etc.)
High content of inorganic salts (especially sulphate and chloride)

3.2 Minimisation of water-use

The improvement of water use also results in the reduction of wastewater discharge and should, in more broad sense, be seen as an integrated part of industrial waste minimisation.

The willingness of the industry to adopt water reduction schemes is very much dependent of economic factors, mainly the cost for purchased water (tariffs) compared to the capital and operational costs for reduction measures. In other cases, for example within the pulp and paper industry, the water quality needs are at a level that requires own or additional treatment of supplied water. Another factor affecting the water consumption is the legislation and local regulations, which can be utilised by the authorities to force the industry to take water conservation measures. Water saving could also be promoted by different kinds of governmental incentives or subsides. It should also be noted, that in some countries, reuse of water for certain purposes, is prohibited by the legislation (mainly of hygienic reasons).

The design of water conservation programmes and waste minimisation schemes is very much related to the specific industry in question. However, the possible measures can be divided into two major groups – low cost options and medium to high cost options. General examples of available options are given below.

Low Cost Options

- Improved housekeeping
- Closing the water flows not in use – estimation of the true water need
- Throttling down flow by the installation of fixed flow limiters
- Improved maintenance and reparation of leakages immediately
- Use of mechanical cleaning operations instead of water (at least pre-cleaning)
- Installation of level controlling devices to avoid over-spill
- Collecting waste in dry form (Reduce the need of flushing/cleaning)
- Allowing higher temperatures in cooling systems
- Fitting flushing hoses with self-closing nozzles
- Installation of conductivity meters for controlling make up water (rinsing, cooling etc.)
- Collection and reuse of steam condensate
- Consider serial use of cooling water (e.g. cooling water for a zinc plating bath can be utilised as rinse water)

Medium to High Cost Options

- Improved rinsing operations and reduce of drag out losses
- Establishing counter current rinsing systems
- Circulation of process water after appropriate treatment
- Circulation of cooling water including installation of cooling towers
- Reuse of water (when not prohibited by the law or other regulations)

- Replacement of water consuming and polluting production processes with more environmental friendly technique
- Replacement of old obsolete equipment with low water consuming ones (e.g. low treatment bath ratio for dyeing machines etc.)
- Reuse of low contaminated or treated water
- Establishment of local treatment and subsequent reuse (ion exchange systems, evaporators etc.)

3.3 Prevention of water pollution

The strategy for reducing water pollution will depend on the type of industry and prevailing local conditions. A summary of options for water pollution abatement is presented below:

Waste water treatment:

- Local treatment plant
- Co-treatment with municipal sewage
- Local pre-treatment followed by co-treatment with municipal sewage

Internal measures:

- Minimisation of chemicals used in the process
- Substitution of harmful chemicals
- Reuse of chemicals
- Minimisation and reuse of rinse water

The ideal mitigation options would depend on the specific type of industry and prevailing conditions. The choice between local waste water treatment and co-treatment with sewage for example depend on the type of industrial effluent, availability of municipal sewage treatment plant and the possibility of using treated sewage or sludge from this plant in the agricultural sector.

In annex 1, a selection of waste minimisation and mitigating measures are presented for a number of heavily polluting industrial sectors. The purpose of the presentation is just to give a broad overview of the work required to significantly reduce the industrial contribution to the adverse environmental impact.

3.4 Cleaner Production

Cleaner production (CP) is a new and creative way of thinking about products and the manufacturing process. CP is achieved by the continuous application of strategies to minimise the generation of wastes and emissions.

Cleaner Production could be defined[1] as the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment.

- *Production processes*

Conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes.

- *Products*

Reducing negative impacts along the life cycle of a product, from raw materials extraction to its ultimate disposal (from cradle to grave).

[1] According to UNEP

- *Services*

Incorporating environmental concerns into designing and delivering services.

Cleaner production requires changing attitudes, responsible environmental management and evaluating technology options. Other preventive approaches, such as eco-efficiency and pollution prevention, serve similar goals.

It is helpful to thing in terms of two categories of enterprise:

1. *Large enterprises that possess ample management and technical skills.* The managers are used to focusing on the good housekeeping aspects of many win-win opportunities. Thus, good environmental performance simply becomes another dimension of the continuous process of implementing efficiency and quality improvements that is required to compete on quality of output as well as price.
2. *Small and medium-size enterprises that have little experience of how to upgrade the quality and efficiency of their production.* Few of the conditions that promote the adoption of good management practices apply and the firms' environmental performance will reflect the general weakness of their management and operational practice.

The CP approach differs from the conventional way of thinking, which very much focus on what to do with wastes and emissions after they have been created, otherwise known as 'end-of-pipe' treatment.

The goal of cleaner production is to avoid generating pollution in the first place. This strategy frequently cuts costs, reduces risks and identifies new opportunities. Cleaner production can be the most efficient way to operate processes, produce products and to provide services. Costs of wastes, emissions and environmental and health impacts can be reduced and benefits from these reductions and new markets can be realised.

It is, however, not always possible to solve all environmental problems by adopting the CP approach. In most cases CP has to be supplemented by other interventions to reduce the environmental impact to an acceptable level. It is also true that there are a lot of opportunities to save money by taking various CP steps but one should consider of that this actions many times require substantial investments, which could affect the economical outturn in a shorter term. Cleaner Production measures and minimisation techniques should *always* be considered in the initial stage even though they could not solve all problems. The environmental advantages are obvious:

- The need of raw material is reduced, which is good not only for the economy but also from a resource management viewpoint.
- The generation of solid waste is minimised
- Reduced wastewater quantities to treat are equal to lower investment costs but also significantly reduced operational costs.
- The need of energy and treatment chemicals is minimised.
- Lower wastewater quantities means lower discharges of pollutants.

4 Targets and standards for pollution abatement

There are a number of approaches in setting standards and targets for pollution abatement. Some differences in approach include:

- Effluent standards or ambient standards
- Uniform norms or targets set according to local conditions (for effluent or ambient standards)

Some specific strategies include technology based standards (TBES) and river basin approach.

4.1 Uniform effluent standards

A uniform standard for discharge within a nation or region set by government agencies is in principle an approach that is easy to applicate. However, this approach does not allow for optimisation of measures within a region and will many times lead to high costs without the corresponding benefits in terms of improvement of ambient environment and quality of receiving waters. It also often undermines attempts to encourage the better plants to any improvements. Furthermore, few environmental authorities have the resources to enforce emission standards strictly for more than a limited number of plants at a time, especially if frequent monitoring of operational performance is required. As a result, reducing emissions from the worst plants may be a lengthy and resource-consuming process.

Setting strict discharge standards within a country has a very strong appeal to both environmental policymakers and those whom they regulate. Attempts to enforce uniform environmental policies throughout large diverse countries will be doomed to failure. This dilemma is usually resolved by establishing a minimum set of incentives, standards and other interventions.

Minimum requirements imply that no subnational authority is permitted to adopt less demanding policies although in practice such variations may occur as a result of differences in enforcement behaviour. The extent of such minimum requirements varies greatly across countries, but everywhere they tend to include measures for dealing with the most sensitive environmental issues. In all countries, it will be the responsibility of national authorities to propose and broker agreements on the extent and nature of such core requirements. In India for instance, the central government proposes standards for industry discharge to watercourses. These standards are minimum requirements and it is up to each state to introduce stricter standards if practical.

Most countries with an environmental legislation have found it convenient to prescribe uniform effluent standards, with permission to states and local authorities only to be stricter than these standards to cater local environmental conditions. Uniform emission standards are seen to avoid the problem of imbalancing competitive equity, while ambient quality standards would require a system of environmental baseline reporting that is generally not in place. In some countries effluent standards are coupled to the quality of the receiving waters; more pollution is allowed into watercourses that are already polluted. In former Soviet Union and some other countries have used a classification system separating rivers into three or four classes depending on existing pollution. Some countries in Latin America have similar classification systems.

4.2 Targets at the enterprise level

Specific targets for each polluting industry alone will not be an efficient instrument to set priorities and deal with more complex problems. However, in combination with a regional or river basin approach and possibly based on some uniform standards it provides an important instrument for the internal management at industries.

One option is to focus on raising the standards of the best managed companies among the polluters, hoping that the others will gradually improve by learning from the good examples. This strategy is most likely to be effective when competition and social pressure provide a stimulus for improvements in operational as well as environmental performance. Even then progress tends to be limited for the worst plants, and the only solution may be to force them out of business.

Environmental performance of an industrial should be considered as a part of the overall operational efficiency and quality management. The objective should be the progressive reduction of emissions that are linked to important environmental standards. The focus needs to be more on operational practices, good housekeeping, and the training of workers than on the technological and design specifications of pollution controls.

The achievement of environmental targets may start with the installation of new controls (monitoring) at the sources responsible for the most damaging discharges. This is accompanied by arrangements to monitor discharge characteristics. However, difficulties ranging from disagreements about who should bear the costs to how to interpret the results of monitoring will occur.

Probably, it will be necessary to negotiate with many enterprises, each of which will have many reasons to delay or modify the strategy proposed. The outcome will be some balance between a top-down approach based on some combination of discharge standards and economic incentives, and a bottom-up consensual approach in which agreements about targets for each industrial plant are laboriously reached on the individual or a collective basis.

4.3 Technology Based Effluent Standards

A technology based effluent standard (TBES) is an effluent standard set at the level of emissions that a source would produce if it were employing a particular abatement technology. The regulating agency studies the effluent abatement technologies and procedures available to a particular industrial operation; after having selected on technology from among the many available, it sets the emission standards at the level produced by that technology.

Types of TBES includes:

- Best available technology (BAT), usually with the provision added that it should be economically achievable.
- Best Practicable Technology (BPT)
- Best Conventional Technology (BCT)

Technology based standards are seen as way to find targets that are applicable and could be implemented since they are derived from available technologies. However, these approaches are open to interpretation and do not take into account the need to set standards according to the quality and use of the receiving waters nor what is "available" or "practicable" according to local conditions.

4.4 Ambient standards and the River basin approach

Ambient standards are a maximum level of pollutant in the receiving water bodies. This approach allows for setting priorities and adjusts the specific targets for individual industries according to the water quality goal. An ambient standard could either be uniform for a country or region or local according to the quality and use of the receiving water body.

In a strategy that is sometimes called the River basin approach targets and strategies are set up for a river basin. Strategies include identifying and evaluation of different pollution sources, developing a program to mitigate pollution according to the overall water quality goal, and sometimes the establishment of a specific organisation to implement this program. The major advantage of this approach is that it maximises efficiency in meeting ambient standards since the individual polluter or the group of polluters is likely to achieve the targeted level in the most efficient manner. The major disadvantage is administrative complexity. Discharges still need to be monitored and violations noted. Since it is more complex, there are probably more opportunities for malfunctions of weak administrations in monitoring, issuing of licensing and in checking of the license against observed discharges. This approach needs therefore be combined with uniform standards and specific targets in its practical implementation.

Where there are few significant sources of pollution in a river basin, it is fairly easy to reach agreements with the polluters to improve their performance. Where the river basin encompasses a large metropolitan area with numerous sources, a range of instruments should be applied, tailored to the capacity of the various implementing agencies. First, there should be a clear understanding of the contribution of different sources to water quality and of the options at each source that would lead to cost-effective overall improvement in quality. The key to success is to keep the solutions as simple as possible and to ensure transparency and accountability on the part of all involved. In poor countries or communities, the need to devolve responsibility to the local level may sometimes be even more important than in wealthier communities. Experience shows that local communities are willing and able to organise effectively to provide basic urban services (reliable drinking water supply, basic sanitation, solid waste collection etc) at affordable cost and in a sustainable manner, if municipalities or higher-level government authorities provide appropriate incentives.

4.5 Enforcement of standards

Strict standards per se often do not lead to a cleaner environment. In some cases, initial compliance with standards deteriorates; for example pollution control equipment is installed but is subsequently poorly maintained or bypassed. In many cases, there is no enforcement culture, and the strict standards are ignored altogether. As mentioned above, Syria has no environmental law and guidelines for water pollutants are issued under the law of irrigation, see textbox 4.6.

Example: Water guidelines in Syria

Non-decisive guidelines exist for the assessment of wastewater from industries and municipalities. Strict standards only exist for the discharge of industrial wastewater into municipal sewerage systems. When an industry exceeds the guideline values, local authorities and the Ministries of Industry and Housing and Utilities are informed. In practice there is not much difference between the guidelines and the standards. When guideline values are exceeded no legal way exists to force anybody to make improvements. Even if introduction of standards for discharge of industrial waste water into municipal sewage systems open up the possibility of using legal measures, such are usually not used because industries are not supposed to manage to pay for the cost of improvement. Moreover, anybody neither by the authorities, nor by the industry has the know-how of what technical improvements are needed.

Textbox 4.1: Water guidelines in Syria

The strict-standard approach has been strongly criticised in the area of encouraging cleaner production. It has been observed that environmental regulation has historically had minimal effects on encouraging non-polluting technology. End-of-pipe technologies or those added on to production processes have been the predominant responses to environmental standards. However, new demands for

improving environmental conditions require technology-forcing standards and flexible agency procedures for encouraging technological assistance to the industrial enterprises.

5 The legal framework: policy, legislation and monitoring.

The legal framework for environmental protection at industries can somewhat simplified be seen as chain from broader goals to specific – often local – action. From general government policies, transformed to strategies or action plans to legislation implemented through the employment of Environmental Impact Assessments (EIA) and Environmental Permits. The conclusions of the EIAs and conditions of the permits in turn form the basis for the legally compulsive monitoring.

5.1 Environmental Policies

Environmental progress in most countries has relied on legal instruments such as ambient or emission standards for pollution control. As a consequence, a wide range of control technologies has been developed and it is now technically possible to greatly reduce or entirely eliminate discharges of the major pollutants. This approach has been successful for dealing with pollution problems in rich countries, however, in many developing countries the necessary preconditions for implementing pollution control measures do not exist and some countries fear that pollution control is an expensive luxury that will divert resources from more productive uses.

Other developing countries have been very impatient to adopt environmental regulations of international standard. However, poor control of environmental problems in developing countries are often not caused by inadequate regulations but by lack of environmental priorities and shortage of trained manpower in the environmental control authorities.

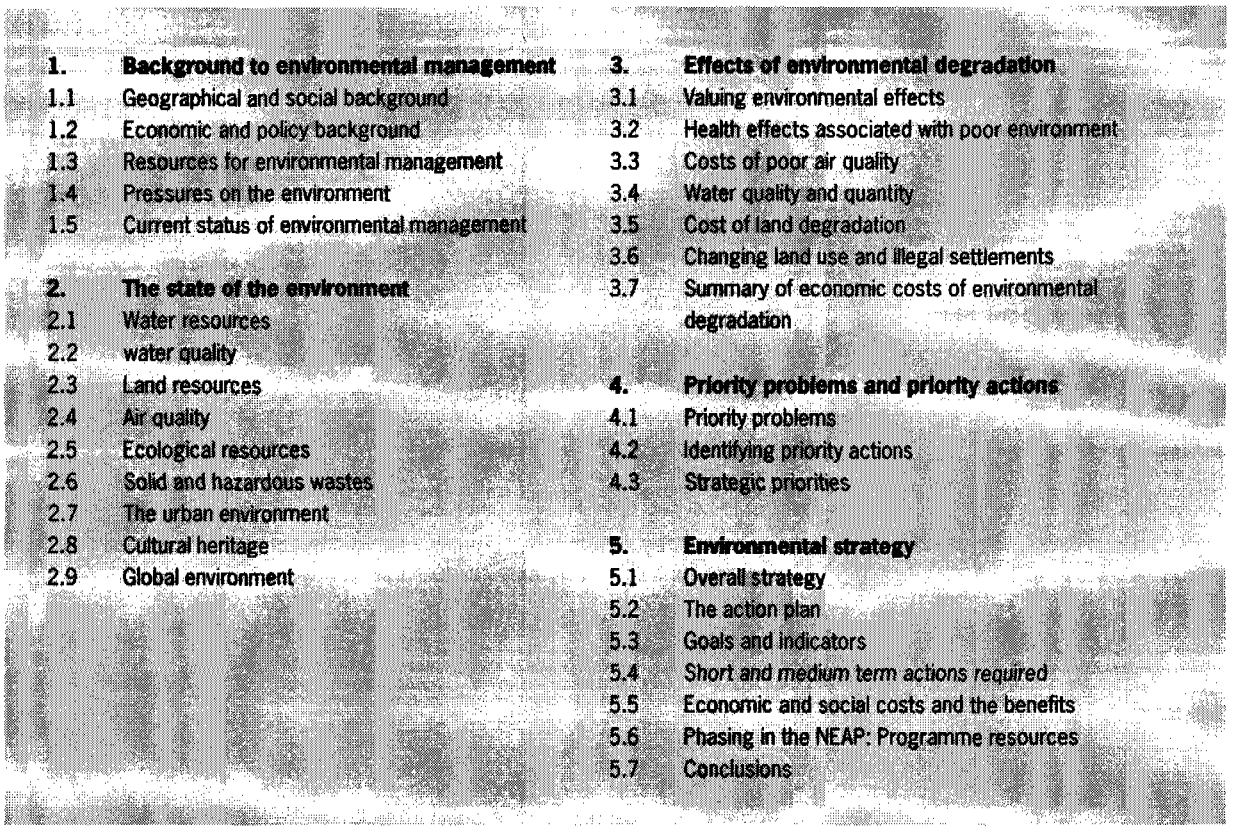
To achieve sustainable solutions to environmental problems each country should develop its own environmental strategy including an action plan and shift the emphasis to environmental management, using a broad mix of incentives and pressures. To make national environmental policies successful they should relate to and support national socio-economic goals. Environmental policies designed in isolation of national development goals are difficult to implement and frequently fail. Conversely, many of the policies adopted to increase production lead to inefficient or destructive use of natural resources, with long-term negative impacts on both the environment and economic development.

Successful environmental policies involve:

- Definition of environmental policies in terms of goals rather than measures
- More explicit consideration of priorities and formulation of action plans
- Greater decentralisation with respect to the implementation of policies
- Promotion of improved performance and management rather than just control of emissions
- Adaptation of cost-effective strategies rather than specifying particular control measures.

5.2 Environmental Strategies

An environmental policy to be functional should include a plan for the implementation of environmental projects. The document presenting the environmental strategy is often called National Conservation Strategy (NCS) or National Environmental Action Plan (NEAP). The first name is the most common when IUCN has assisted in the preparation and the last name when the World Bank has been involved. Both NCS and NEAP may cover a wide spectrum of topics depending of approach and national priority settings. However, high quality products of either kind tend to contend the same main key items. An example on items covered by a NEAP is presented in textbox 1.



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Textbox 5.1. Examples of topics covered in a National Environmental Strategy (World Bank Model)

In many countries, the task of improving environmental performance is complicated by reluctance to define environmental priorities and (or) to articulate clear strategies that address them. An environmental strategy is both a product (the strategy document) and a process (consensus building and mobilisation of a constituency support).

In order to settle the strategy a great number of experts have to come together to focus on the way their sectors affect and in turn are affected by the environment. One of the more successful environmental strategies so far has been prepared by Pakistan (the Pakistan National Conservation Strategy, 1991. See textbox 4.2). The entire process – workshops, seminars, public hearings, and lectures – took three years and involved some 3000 people.

Example: Pakistan's National Conservation Strategy (NCS)

Pakistan's NCS was approved by the Cabinet in 1992. Following the approval of the NCS, a cabinet Committee was established to oversee its implementation.

The NCS has three explicit objectives:

- Conservation of natural resources
- Sustainable development
- Improved efficiency in the use and management of resources

Three main operating principles identify the methods and approaches that will enable these objectives to be reached:

- Achieve greater public partnership in development and management
- Merge environment and economics in decision making
- Focus on durable improvements in the quality of life

A four-component Action Plan was adopted for the implementation of the NCS. Through this approach it would be possible to address simultaneously:

- strengthening of institutions, in particular technical, regulatory and participatory institutions
- Creation of a supportive framework of regulations and economic incentives,
- Formulation of a broad-based communications campaign for mass awareness, and
- implementation of projects in the NCS priority areas

The NCS document contains 13 chapters:

1. Pakistan in the context of the global environment
2. The state of Pakistan's environment
3. Resource use impacts and linkages
4. Existing institutions
5. Present policies, instruments and programmes related to the environment
6. Objectives, principles, and instruments
7. Issues and opportunities in the primary sectors
8. Issues and opportunities in the secondary and tertiary sectors
9. Supporting programmes
10. Action agenda and implementation strategy
11. Government and corporate institutional development
12. Co-operation with community organisations and NGOs
13. Financing the NCS

Textbox 5.2 Pakistan's National Conservation Strategy

Many national presentations to the UNCED conference in Rio de Janeiro 1992 are environmental strategy documents. However, many of these documents seem to be the product of small groups without participation of other interest groups. Some general aspects on environmental policy formulation are given in the following sections.

Not even a completed strategy document will make any change in the absence of an ability to implement the recommendations. The key to change is political commitment by governments to environmental policies and environmental awareness among broad groups. Effective environmental management depends on making choices. These choices form the basis for developing targets that can be understood and assessed by communities and the public as well as by specialists.

5.2.1 Setting priorities

Environmental policies should aim at concrete goals that mean something to the public and politicians and then focus their attention on achieving real progress. Environmental control in rich industrialised countries focuses on point sources of pollution whereas from the perspective of developing countries

the management of natural resources such as drinking water or water for irrigation is the more critical issue.

Highly visible projects are most likely to be successful. Lack of clean drinking water is among the most important environmental problems and the improvement of drinking water quality is an example on a feasible concrete objective. It is easy to tell whether policies affecting this issue have been effective, and it is possible to gain considerable political capital from addressing that issue. However, this strategy will succeed only if progress toward meeting the goals is regularly monitored and the strategy is revised in response.

Newly observed problems are often claimed to be critical even if they have little impact on human health or sensitive ecosystems. Conversely, serious issues (e.g. water borne parasitic diseases) may go unnoticed because people have lived with them for long time. Problems that are relatively easy to solve but have large demonstrable benefits (e.g. effective sewage removal and treatment) are sometimes ignored in favour of concentrating on complex problems that require very large amounts of resources to address. Some of the thinking on these issues is influenced by the priorities of rich industrial countries that have already solved many of the "basic" problems with which developing countries still have to struggle.

5.3 Legislation

Environmental laws have been passed rapidly in many countries. Unfortunately, however, their implementation has not always been possible either because the laws have been too ambitious or unrealistic or because they have lacked effective instrumentation and institutional support. Moreover, some environmental laws have failed because they do not match the economic reality of the country or because they do not take into consideration the capabilities of the institutions that have to implement them. In general, environmental legislation in developing countries has advanced faster than capacity of management and enforcement. Consequently, many such laws have become very difficult to implement. However, the rule of thumb has been that the more general the law, the less it has been applied. The proposed environmental law in Syria is a framework law providing the fundamental and general principles for environmental protection. It adopts the principle of integrated pollution control, it gives mandates to the preparation and submission of Environmental Impact Assessment (EIA), and the inclusion of environmental considerations in any administrative permit.

Example: Syria's Proposed Environmental Law

Articles 1-7	deal with definitions, establishment of a General Commission for Environmental Affairs, a Supreme Council for the Safety of the Environment, and the responsibilities of these bodies and of the Minister
Articles 8 and 9	deal with discharges of pollutants and the responsibility of persons who are causing environmental damage.
Article 10	considers the appointment of sworn-in legal officers who are empowered to deter violations to this law.
Article 11	gives the definition of an Environment Protection Fund
Article 12	deals with consequences for those who are indicted of violating this law.
Article 13	sets a grace period of two years for polluting establishments to adjust to environmental guidelines and standards. This period may be extended to five years for specific establishments.
Article 14	states that the Council shall issue instructions, which are needed for implementing the intention of this law.
Articles 15 and 16	finally contain official notifications.

Textbox 5.3: Syria's Proposed Environmental law

To make the Syrian law effective, a large number of executive decrees are required. Also, the strengthening of environmental institutions on all levels will be necessary to ensure full compliance with the law. The emphasis of the proposed law is rather on punitive and curative actions than on incentive and preventive measures. Though the Environmental Law has not been issued, two of its articles are being applied through Ministerial Decrees. The first Decree (Article 11) is on the establishment of a Fund for Environmental Protection, which will provide a source of financing from the treasury and from donors to the General Council of Environmental Affairs. The second article is applied through a circular from the Ministry of State for Environmental Affairs requesting all ministries to include a questionnaire on environmental screening to all new investment projects. Response to this quest is a pre-requisite to the issuance of any administrative permit by the Governments.

In many draught-ridden countries, water-pollution aspects have been introduced into other specific water laws. In Syria, where agriculture is very important of tradition, the irrigation law includes rules for water pollution from industry.

In India mandatory standards for discharge of pollutants are prescribed under the Environmental Protection Act from 1986. However, most rules of importance for the prevention of water pollution are found in the Water (Prevention and Control of Pollution) Act from 1974 (Textbox 4.5)

Example: India's Water (Prevention and Control of Pollution) Act, 1974

The objective of this law is the prevention and control of water pollution and to restore pure water. Powers have been given to the State Pollution Control Boards to regulate effluents, which are likely to cause pollution. To obtain this, the state PCBs are given the right to inspect industrial units and collect samples of effluents.

The PCBs grant or refuse permits to industries after checking of pollution control equipment and characteristics of discharged sewage water.

Textbox 5.4: India's Water (Prevention and Control of Pollution) Act, 1974

5.4 Environmental Impact Assessment

Environmental Impact Assessments is now a widely used tool to take environmental concerns into decision making. It should be noted that the term is used in different contexts. It is used as a tool in the development and screening of development projects. In this case the process are by some agencies such as the World Bank referred to as Environmental Assessment (EA), but Sida uses the term EIA for this application as well and has presented a policy in "Guidelines for Environmental Impact Assessments in Development Cooperation" for this purpose.

An Environmental Impact Assessment process is also a key element in the legal framework for environmental protection. Where new projects are being developed, the key to sound environmental performance lies in a comprehensive environmental impact assessment (EIA), that must be carried out before any new industry is established or when an industry applies for an environmental permit. An EIA should be based on close collaboration with local authorities and the community. To the extent that the EIA represents a genuine effort to reach a broadly accepted plan of action, the subsequent environmental performance can be expected to be far better then if the project is simply required to meet independently established strict standards. The EIA concept is now widely accepted even in some countries still waiting for a full environmental legislation. However, as in environmental management in general the bottleneck will be the capacity of the EIA controlling authorities and environmental assessment rules are not followed in too many cases.

Where existing industrial facilities are to be rehabilitated, an environmental audit will provide the necessary information on which to base cost-effective measures to significantly upgrade the environmental performance.

5.5 Environmental Permits

During the last 20 years environmental permits has been introduced in the environmental legislation of many countries as mandatory for specified new projects. In most cases if not all an EIA procedures is required before setting up a new industry and forms the basis for setting site specific standards stipulated in the permit.

The environmental permit is a key instrument for government bodies at national and local level to regulate the environmental performance of industries.

It is generally necessary to tie environmental permits to other permits such as business licence in order to enforce application and compliance of the permits.

In Syria for example all new enterprises all new enterprises, irrespective of polluting or not, need an environmental approval before they can apply for business licenses. Theoretically, an EIA is needed for the environmental permit, however, so far this procedure has not been applied to any object in Syria.

5.6 Monitoring

The term monitoring includes both general monitoring of ambient levels of pollution and monitoring of discharge of individual industries.

The conceptual model underlying most pollution management is that emissions of pollutants lead to changes in ambient levels, which in turn control the impacts on health and environment. The ultimate concern is the impacts, but in practice, data on ambient pollution are often used to provide information on background conditions and as a basis for policy setting. Work with emissions data are common because they are strongly related to the pollution sources and because they are more easily measured and managed at a specific site. The emissions requirements however must be related to estimates of the overall impact on ambient levels and ultimately on the environment.

Emissions' monitoring is usually carried out to collect information for the design and operation of pollution control systems or for regulatory purposes. For operational purposes, a small number of parameters (or surrogates) may be measures on a regular or continuous basis. Sampling schedules for regulatory requirements are typically very specific.

Emissions monitoring should include measurement of flow rates, although a surrogate such as production rate is often used. Flow measurements are necessary to convert measures of concentrations into estimates of pollutant loads. Continuos monitoring methods are available for many of the most important water pollutants, but the value of the additional data obtained needs to be weighed against the cost and complexity of such systems.

5.6.1 Division of responsibility in monitoring of industries

The system of monitoring could be handled by either the government agencies or as self-monitoring carried out by the industries themselves to be revised by government agencies. The degree of self-monitoring for a particular country would depend on the prevailing culture and traditions in the country.

There are a lot of merits to self-monitoring by the industries.

- It gives the industries direct feedback on environmental performance and a better understanding that encourages behavioural changes.
- Enables the industries to combine the monitoring stipulated by legislation or environmental permits with Environmental Management Systems (see chapter 8).
- Frees government agencies of the task of practical monitoring, enabling them to carry out a more strategic approach to enforcement of environmental legislation.

To enable government follow-up of self-monitoring industries the environmental report generally plays an important role. The environmental report stipulates all forms of discharges and utilisation of resources such as water as well as measures undertaken for environmental protection. The contents of an environmental report could be stipulated in generic terms in the environmental legislation and more specifically in the environmental permits.

Despite the obvious advantage for government agencies of the self-monitoring approach they are many times reluctant to let go of the practical monitoring. The ideal solution for a division of responsibilities between government agencies and the industrial sector is generally an important aspect in developing projects for water management of the industrial sector.

Example: Monitoring of water quality in Syria

The Ministry of Irrigation is responsible for monitoring and assessing water resources quality, industrial effluents and domestic wastewater discharges through Syria. The central office in Damascus is also responsible for the Barada and Awaj basins. There are regional offices responsible for the monitoring in the other river basins. All monitoring in the rivers is carried out manually once a month at fixed sampling points. The samples are analysed for seven common chemical parameters by the regional laboratories belonging to the Ministry. Personnel from the laboratories perform all sampling. Analyses of E. Coli are performed each second month and of heavy metal each fourth month.

Textbox 5.5. Water monitoring in Syria.

Example: Water monitoring in Rajasthan

The Pollution Control Board (PCB) is responsible for collecting samples from industrial effluents. About 1500 water samples are analysed at PCB's laboratories annually. No system for compilation or dissemination of collected information exists. The analyses are usually limited to pH, COD, BOD, hardness, and alkalinity. Heavy metals are analysed in special projects. The PCB staff also gives advice directly to enterprises how to improve water treatment. About 5000 industries are inspected annually.

Textbox 5.6 Water monitoring in Rajasthan

It is important to note the distinction between self-monitoring of industrial pollution as stipulated in environmental legislation or permits and voluntary environmental management systems described in chapter 8.

6 Economic incentives and disincentives

Economic incentives and disincentives are the two major categories of instruments that can be harnessed in support of environmental policies. Each in turn can influence the implementation of environmental policies in two ways: through stimulating adjustments to the allocation of scarce economic resources between sectors and through encouraging the adoption of improved resource management (See textbox 6.1).

Incentives	*Grants* Can be targeted either towards meeting physical requirements (e.g. purchasing of equipment) or training of workers. Positive environmental results have been achieved for specific projects.
	Subsidies May have a useful role to play for speeding the adoption of desirable practices. In designing a subsidy programme, particular care needs to be taken to avoid any possible indirect adverse effect
	Fiscal relieves /Concessions Could be used to assist in providing appropriate market signals
Disincentives	*Levies/taxes* Could be used to discourage specific environmentally damaging practices ("Pollution taxes").
	Penalties (fines etc) To be use as a last resort when it is clear that damaging practices have been carried out

Textbox 6.1 Economic incentives and disincentives

Possible economic instruments for improved water management include:

- ***Water use charges*** are generally low or non-existent and many industries use their own wells. By introducing a fee for using water the industries will have an incentive to reduce the amounts of water used.
- ***Effluent charge by volume*** is a charge on amount of wastewater, which is discharged, to the municipal sewage system or collective treatment plants. This provides a similar incentive as the above to limit the amount of water used.
- ***Emission charges*** are charges based on specific pollutants in the wastewater, which gives the industries an incentive to reduce the pollution discharge through wastewater treatment or cleaner production.
- ***Product charges*** are charges or taxes on products are polluting in the manufacturing, consumption or disposal phase.

In a country with weak legal basis and institutional framework, economic instruments will be difficult to implement. In many developing countries the introduction of charges related to the use and pollution of water resources must be combined with the strengthening of the overall environmental legal framework and capacity of relevant institutions. The following issues should be addressed before a new water use or pollution charge is considered:

- *Legal basis* should be analysed and harmonised with the implementation of the new charges.

- *The institutional framework* must be capacitated to be able to implement and enforce the charges. Normally the relevant government agencies are not equipped and staffed to deal with enforcement and administration of levies for economic instruments.
- *Political commitment* from the entire government is required.
- *Consensus among stakeholders* such as government agencies, industries and affected communities is crucial aspect for a major policy change such as new levies.
- *Enforcement* holds the key to implementation of new charges for water use and pollution as well as other types of economic incentives. The development of a strong system of enforcement relies in turn on the issues raised above.

7. Institutional framework

When formulating and implementing a project for improved water management at industries and municipalities the analysis of the institutional framework many times holds the key to a successful outcome. Public institutions in developing countries are many times weak with unclear and overlapping responsibilities.

Successful implementation usually requires the involvement of different institutions on both national and local level participating in accordance with their role and mandate. Furthermore, private sector organisations play a vital role in issues related to environmental management at industries.

7.1 National environmental authorities

The scarcest government resource is frequently not money but administrative capacity and that political pressures make environmental policymaking particularly difficult, governments must think carefully about what they do and how they do it. The main responsibility of the environmental management consists of setting priorities, coordinating activities and resolving conflicts, and creating responsible regulatory and enforcement institutions. The institutional response to these tasks includes developing legislation and administrative structures, providing needed skills, ensuring funding and donor coordination, implementing decentralisation and delegation.

When formulating and implementing national policies and regulations there is generally a number of ministries and other government bodies on a national level involved. The responsibilities and mandates of different ministries will naturally differ from country to country but could for example include:

Ministry for Environment, having the primary responsibility for formulating and enforcing environmental laws.

Ministry for Water Supply and Public Works, having a national responsibility for water supply and working with the municipalities.

Ministry for Health which mandate for health related issues usually include environmental related responsibilities.

Ministry of Agriculture which would need to be included for an integrated water management approach.

Ministry for Industry and Trade, having the direct responsibility for development of the Industrial sector.

7.2 Local

Local governments play a central role in managing the urban environment. They usually – through a municipal department for water supply and public works – bear the primary responsibility for urban infrastructure and land use planning and are often directly involved in the provision of basic water and sanitation.

Many larger cities and municipalities would also have a local body responsible for the local enforcement of environmental regulations. It is important to analyse the role of such a department vis-à-vis both the corresponding national government bodies as well as the municipal department responsible for water supply and sewerage

7.3 Delegation of responsibility

The division of responsibility for environmental policy and regulation will depend on historical, social and legal factors. Just as environmental authorities should not attempt to micromanage the decisions of individual enterprises and plants, national agencies should focus on the broad framework of priorities and instruments while delegating responsibility for detailed strategy and regulation to regional and local bodies wherever possible. A prerequisite is however, that adequate resources are allocated to the regional and local bodies.

The overall legal and institutional framework should cover legislation that establishes specialised regional agencies such as water basin authorities or that gives national or sub-national agencies power to inspect premises, collect data, and impose various penalties. The lack of such legislative framework has caused serious problems in countries where provinces or states have attempted to introduce discharge fees to recover the costs of dealing with water pollution and to provide an incentive for polluters to reduce their discharges.

Given the difficulty and variety of these many functions, strong institutional capacity – including adequate funding, efficient organisation, clear lines of authority, and qualified personnel – is necessary if local governments are to be effective environmental managers. Unfortunately, such capacity is too often lacking. In many developing countries, local governments cannot provide basic urban services, let alone regulate and enforce environmental legislation. In Europe, when pollution became severe, the legal, regulatory and financial structures to implement environmental management already existed. In contrast, many cities in developing countries are facing new pollution threats with weak institutional structures, inadequate capital budgets, backlogs in providing basic infrastructure, and economies far less able to generate the needed capital

By the late 1980s, a distinct trend toward decentralisation emerged, with a majority of central governments transferring some degree of political power back to local units of government. However, in some countries decentralisation appears to have occurred only in name. The central government continues to appoint municipal officials and control local spending decisions. In short, decentralisation has not always resulted in a real devolution of power to local municipalities.

8. Role and incentives for the industrial sector

The industrial sector itself has a key role in improved water management at industries.

In the industrial sector the management and financing of environmental protection lies with the owners of the enterprises (either private or public owners), while the governmental institutions (municipal, regional and national) have a regulatory role.

The success of the regulatory framework presented in chapter 4 will to a large extent depend on the competence, motivation and culture of compliance at the industries themselves. Furthermore, the industrial sector has increasingly its own incentives for improved environmental management.

8.1 The Polluter Pays Principle

It is generally agreed in industrial countries that the costs for polluting should be internalised. This approach is known as the Polluter Pays Principle (PPP), which has been adopted by all members of the OECD and in the European Union. PPP should be as applicable in poor countries as well. However, there are structural problems in the implementation of PPP in full. Point sources such as industries are relatively easy to handle when dealing with specific substances not emanating from any non-point source or at least when point sources are the obviously dominating sources of pollutants. It is much more difficult to apply this principle when the run-offs from agriculture or emissions from motor vehicles dominate, which often is the case in developing countries.

One way to avoid the structural problems of PPP use in many countries is to require each industry to obtain a licence that permits certain levels of discharge for free, but that charges a high and rapidly rising fee for any discharges above this level. India's Water Cess Act is an example of regulations with this approach.

8.2 Environmental Management Systems

An Environmental Management System (EMS) is a systemised approach for environmental self-monitoring and continuous improvement.

The steps in implementing an EMS generally includes:

- Environmental assessment to identify activities which are affecting the environment and how the industries activities complies with existing law.
- Environmental planning which includes setting policies and objectives as well as action plans to achieve these objectives.
- Control and monitoring of compliance to policies and objectives. The results should be reported.
- Review and improvement: after each audit the EMS shall be reviewed and revised to improve the environmental performance of the company.

There are a number of standards for EMS, the most widely used is the ISO 1400 series. The advantage with a standardised certification of an EMS is that it mechanism for communicating environmental performance with business partners, regulators and the public.

The advantage of implementing an EMS in a developing country context is that it provides structured approach to self-improvement of pollution abatement as well an additional incentive in terms of

improved trading possibilities and public image. For larger export industries in Asia and Latin America this could be a compelling incentive.

A limitation of a certified EMS as a tool for improved industrial management is that the cost associated of an internationally accepted certification is high and therefore not a viable options for small and medium sized industries in developing countries. Furthermore, smaller companies do generally have poor management structures as well as lack of trained personnel and resources to adopt EMS. However, smaller companies can adopt a limited part of the EMS approach (such as systems for self-monitoring and improvement) without developing the system according to internationally approved standards.

Another possible drawback in the impact of EMS is that the ISO standard does not specify the environmental standards to be achieved. The impact of the system would thus rely on the requirements set by regulatory bodies or trading partners as well as the commitment of the industries themselves.

In conclusion, an EMS provides a useful tool in environmental management that will not substitute but rather compliment a regulatory systems by providing a structured approached for self-monitoring and reporting. Governments will play an important role in development of EMS frameworks and in setting standards to which the industries EMS should apply.

8.3 Cooperative approach and negotiated agreements

Confrontational systems of environmental management typically do not work well over a sustained period. Developing and implementing effective environmental strategies requires cooperation between enterprises and other polluters, national, regional and local authorities.

Environmental authorities must at least ensure the acceptance and understanding of most of those whom they seek to regulate, whether in the private or the public sector. A carrot-and-stick approach will still be necessary, but the carrot may be the opportunity to participate in critical decisions, rather than ill-directed financial assistance.

Although not a substitute for regulations negotiated agreements between governments and polluters offers an opportunity to take a first step to environmental protection while regulations are being developed. This approach has been successful to mitigate serious environmental problems in countries with a weak regulatory framework such as Indonesia and Brazil.

8.4 Trade and supply chain incentives

Environmental requirements in international trade have provided a new incentive for improved environmental performance of industries.

Larger industries which serving international markets will be driven directly by the environmental requirements by their trading counterparts in Europe or the United States. These demands could be the development of Environmental Management Systems (see section 8.1) or to fulfil an ECO label requirement.

Some European companies also seek to influence their main suppliers directly with demands and advice on fulfilment of environmental standards such as treatment of wastewater. An example of this is the Swedish clothing retailer Hennes and Mauritz who are working together with their main textile suppliers in India to improve wastewater management.

8.5 Project implementation through the industrial sector

In the implementation of development assistance for improved water management at industries the industrial sector itself has been given an increased role.

Recent experiences within Sida and other development agencies (see the following two case studies) indicates that development of pollution abatement strategies through the industrial enterprises or industrial sector organisations provides an effective implementation modality.

The experiences indicate that there are driving forces within the industries such as public image, trade and general awareness of environmental concerns. These incentives can be explored by supporting the enterprises in their internal management through training in audits, risk assessments, Environmental Management Systems, self-monitoring etc.

Another advantage of implementing a project through the industrial sector is that it does not in general have the same problem of frequent change of staff as in government agencies. This enables the training and capacity building to be more sustainable.

It should also be noted that efficient regulatory control relies on the compliance, co-operation and competence of the industrial enterprises. To raise the awareness and motivate the industrial sector there is a need to provide regulatory and financial incentives. The "regulatory" and "industrial sector" approach should therefore be combined.

Case study: Environmental Protection at Bolivian Industries

The PAIB-project, "Protección Ambiental en la Industria Boliviana" was initiated in June of 1998 and is expected to terminate in May of 2000. The project is financed by ASDI with CNI, Cámara Nacional de Industrias in Bolivia, as counterpart and the Swedish ÅF-SCC group as implementing consultant. The regional industrial chambers in La Paz, Santa Cruz, Cochabamba and Oruro have been involved as regional counterparts, representing altogether more than 80 % of the Bolivian industry. The project budget has been 14.4 MSEK, corresponding to 1.7 MUSD, financed by Sida and an additional 0.5 MUSD financed by the Bolivian counterpart.

The main objective of the project is "To obtain an eco-efficient production in the Bolivian industry that will contribute to a sustainable development and an increase in the competitivity" whereas the specific objetive is "To improve the environmental conditions in the Bolivian industry with an increase in the international competitivity as a consequence."

Basically the project is an educational project in two phases. In the first phase a total of twelve Bolivian trainers were trained in environmental matters with the help of Swedish consultants. The training included introduction to environmental development and legislation, self-monitoring, Environmental Management Systems, Environmental auditing, risk analysis etc.

One of the unique features with the project is that several of the modules, which in most projects of this type are mainly theoretical, have been applied practically in several key industries.

The idea of practical training in selected key industries has proven to be very efficient. However, one obstacle during the implementation was the selection of the key industries. Few industries were interested to participate since they were afraid that the information obtained could be used against them in one way or the other by the authorities. Since we have been working directly with the private industrial sector and their interest organisations, the industrial chambers, we have managed to build a mutual trust between the PAIB project and the participating industries.

The majority of the participants in the main training programs are coming from the Bolivian industry, but there are also representatives from authorities, universities and consultant companies. In the beginning of the project there were some clashes between authority and industry representatives. During the project we have also managed to build some new mutual understanding between representatives from the authorities and representatives from the industries. The discussions between these groups were from the beginning mostly emotional and sometimes very harsh, but a clear development towards constructive and fruitful discussions has been noted, especially during the latter part of the project.

One complicating factor concerning the cooperation with the authorities has been the high rotation of the authority personnel due to political reasons.

Conclusions
The main conclusions of the project up to date can be summarised as follows:

- It is very efficient to work directly with the receiving organisations, in this case the industries and their member organisations the industrial chambers. A filtration of the project funds via governmental organisations would have been detrimental to the projects due to the high rotation of the authority personnel, the lack of efficient cooperation between authorities and industry and the high over-head costs within the ministries and other governmental authorities.
- One of the most interesting modules has been the self-monitoring which was possible to implement due to the incorporation in the project of some basic monitoring equipment to each region. The lack of factual data from the industries is a limiting factor for the environmental development. This module should therefore be further developed in future projects of this type and it would be valuable to complete the basic monitoring equipment in order to cover the monitoring needs of each region even better.
- Another interesting feature is that all of the participating trainers and around 20 % of the participants in the main training course had the opportunity to see how the environmental work and the cooperation between authorities and industries work in Sweden. This gave a valuable reference and a clue to how some of the issues discussed in Bolivia can work in full scale.
- It has been clearly stated by several key industries that they realise the severe limitations threatening their export potential if they do not consider environmental implications of their production. Another important factor for the implementation of environmental improvements in the industries is the application of new sewage tariffs as a result of the initiation of private water companies in Bolivia. All used water will therefore be charged as effluent to the industries in the future, which is not the case today since a majority of the industries are using well water free of charge from own wells. These two factors, together with the new environmental laws and regulations, constitute the main driving forces for the implementation of environmental activities in the industries.

Case study: 100 Cleaner Enterprises – Costa Rica

The project "100 Cleaner Enterprises" was initiated in 1995 and aimed at upgrading the industrial competence and know-how in Costa Rica within the environmental field, carry out Environmental Audits in industries as well as to utilise the results for developing environmental improvement plans (Voluntary Compliance Plans) based on "Clean Production Technology" methods.

ÅF-IPK was chosen by Sida to collaborate with MINAE and CEGESTI in elaborating the project activities.

The project activities included initially meetings with and support to industries and organisations that have started to implement their voluntary plan of compliance (VPC). Other initial preparations involved:

- Pre-evaluation of some 100 Voluntary Plans of Compliance
- Implementation of information campaign
- Pre-selection of 30 enterprises.

A summary of the findings from the audits are presented below:

- The Effluent Discharge Standards for the industry were under revision during the work. Many of the enterprises lack sufficient knowledge of what specific Standards do apply to their discharges as well as what future changes might be introduced.
- The Standards are based on concentrations of pollutants. This means that there is no incentive of doing water conservation measures such as storm water separation, etc. For reference, most industrialised countries have adopted Effluent Standards based on quantity of a pollutant rather than concentration.
- Only a very few enterprises had an environmental policy with set objectives, plan of action, implementation schedule and internal Discharge Standards.
- Monitoring of the emissions was in most cases only done at random by grab samples tests. Only two of the industries visited had an acceptable monitoring program in operation.
- Only a few of the industries visited had finalised successfully programs of internal pollution abatement measures including e.g. source identification, separation of storm and clean waters; recirculation of process waters, recovery of spills and adjustments of process procedures and cleaning routines to abate discharges. However, many of the enterprises audited had used mainly internal abatement measures to reach an acceptable emission situation and a lot of such measures had already been implemented.
- Many of the visited industries claimed that they had already invested in or intended to build and/or operate an external effluent treatment plant. The function and efficiency of all plants audited were unacceptable, the main reason being an inferior database used for design as well as, in some areas, poor design.
- Practically all the industries requested further help with respect to evaluating their operations, "revising" their plans of measures and assistance in conceptual design.

In addition to the specific conclusions above, the following general observations were made:

- All participating enterprises but one showed sincere commitment and willingness to co-operate throughout the project
- The results and experiences of working with the participating enterprises clearly indicated that they have adapted a way of thinking and acting in environmental terms, and have learned to focus on the, from en environmental standpoint, most essential questions and tasks
- The produced Voluntary Plans of Compliance are all complied according to a specific format which will enable easier assessment and follow-up

- The need for technological assistance was evident and much greater than what the consultant was able to supply within the frames of this project. Evidently, there is a specific need for independent reviews of plans and designs provided by local consultants and suppliers. Currently, the market for environmental services and equipment is rapidly growing and a rather "wild" market situation has emerged. In this situation the enterprises have a relatively hard time assessing the sincerity and seriousness of the suppliers.

9 Public Involvement and social aspects

9.1 Public involvement

When addressing the issue of use and pollution of water in industries involvement of the public should play an integral part.

Many times the public has a dual role: they are affected by the pollution or excessive water use from an industry but are at the same time relying on this industry as the mayor local employer. The publics support and understanding for the projects is therefore crucial.

Public involvement can help create an informed constituency to influence priority setting and support for enforcement. This involvement can ensure that project are relevant to local needs and respond to local concerns.

Public involvement could include the following aspects:

- Identification of problems and setting priorities. This has traditionally been done solely by experts from specialist government agencies or outside consultants. However, that priority setting must involve all parties including the public.
- Creating awareness. By including an awareness creating component to the development process an informed public can play a crucial part in influencing the industries and government agencies.
- Community monitoring. Public organisation and interest groups can also be given a role in monitoring or environmental vigilance. This requires availability of simple and reliable testing methods that can be used by local communities such as litmus paper strips to monitor the acidity of wastewater or basic kits for testing a variety of parameters. Community monitoring is also a logical extension of the emphasis on improvement ambient environment.

Case study: NGO implemented project in Kenya

A Sida funded project implemented by a local NGO in Kenya with the support of Tema vatten, Linköping University demonstrates both the possibility of projects implemented by NGO:s and the need to closely involve the industries themselves as key stakeholders.

Management of the Industrial Effluents in the Nyando River Basin – aims to improve the performance of the existing wastewater treatment facilities and to demonstrate the performance of constructed wetlands as a cheap and reliable method for improving wastewater treatment at the sugar industries. The project is planned for 3 years and the local partner is a NGO – OSIENALA.

During the first phase of the Nyando River Basin project (1995–1999), the major sources of pollutants entering Lake Victoria were analysed and according to preliminary estimates, sugar industries in the region were found to be significant point sources of organic pollutants (indicated by high BOD and COD). The project group decided to work with industries on reduction of the pollutant load discharged to the river. One of the first attempt was to perform a simple waste audit in the factories and report findings in the form of a report with advices and recommendations. After it was done, little happened at the industries. Later we were informed that the reports were acknowledged, but received little support from the local technical and management staff. After evaluation, the project management decided to change strategy, and involve local staff in the analysis and studies of their own factories, with Swedish partners taking the role of scientific/technical supervisors. This approach received much better reception, and now, there is at least one local coordinator/manager/consultant at each factory involved in the project.

9.2 Gender perspective

The needs and interests of different segments of society must be addressed when analysing the underlying requirement for a comprehensive water management programme.

Women are often the caretakers of domestic water supply and are inclined to take a different view in the balance between water for the productive (industrial and agricultural sector) and domestic sector.

When addressing the water management in the industrial sector in isolation, excluding other end-users the gender aspect is perhaps less pronounced. However, this is not so much an argument against gender mainstreaming as an argument in favour of projects aiming at integrated water resources management.

9.3 Poverty aspects

The poor segments of developing countries many times has a dual role when addressing the issue of water management in industries: both as benefactors of the industrial activities in terms of employment and as end-users of water in competition with the industry.

Apart from gaining employment from larger industries many smaller workshops are owned and managed by lower to medium income families. At the same time these households will many times compete of the water resources and be affected by water pollution. Ownership and use of water resources should therefore always be analysed in a broad context.

When dealing with water management of industries the poverty aspect should be addressed in a holistic approach integrating environmental and social concerns.

10 Development support and cooperation

10.1 Donor policies

With the exception of the World Bank few donor agencies have specific policies pertaining water and environmental management in industries. UNIDO and UNEP have general policies related to environmental management and more technical guidelines related to specific issues.

World Bank

The World Bank has a number of programs and projects related to environmental management in industries and has produced a large number of documents. Perhaps the most relevant and frequently quoted is the "Pollution Prevention and Abatement Handbook". In this report the Bank summarises its key policy lessons for management of industrial pollution related to external donors:

- Focus on those issues where well-directed efforts can accelerate change. Broad environmental progress will come largely as a result of economic change.
- Massive new investment may not be the solution; it may add to the problem. The pursuit of investment projects may distract management attention from smaller but practical improvements and goals. Investment projects should be the reward for better management, not an incentive to attempt to bring it about.
- Avoid soft loans to enterprises (as distinguished from national governments). Apply strict economic criteria in assessing projects. Grants may have a role where there are large external benefits that cannot be achieved by other means.
- Ensure that consultant studies and technical assistance have clear objectives and are directed toward specific needs of enterprises or government.

UNIDO (United Nations Industrial Development Organisation)

The "Business Plan on the Future Role and Functions of UNIDO[2]" states that the future activities of the organisation will be regrouped in two areas: Strengthening of industrial capacities and Cleaner and sustainable industrial development. Activities in the latter focus area include.

- Support programmes on environmentally sustainable industrial development strategies and technologies, including on transfer of environmental technologies within industrial subsectors assigned high priority;
- Development of specific norms and standards relating to environmentally sustainable industrial development strategies and technologies, and implementation of international protocols, agreements and conventions.

UNEP (United Nations Environmental Programme)

UNEP's mission is formulated as: To provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

Agenda 21, adopted by the Plenary in Rio de Janeiro, on June 14, 1992, can be seen as a policy document for the activities of UNEP. In this document some paragraphs relate to industrial activities and water management.

On cleaner production; There is increasing recognition that production, technology and management that use resources inefficiently form residues that are not reused, discharge wastes that have adverse impacts on human health and the environment and manufacture products that when used have further impacts and are difficult to recycle, need to be replaced with technologies, good engineering and management practices and know-how that would minimize waste throughout the product life cycle. The concept of cleaner production implies striving for optimal efficiencies at every stage of the product life cycle. A result would be the improvement of the overall competitiveness of the enterprise

[2] Adopted by the Industrial Development Board on 27 June 1997 and endorsed by the General Conference on 4 December 1997

Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilization.(...) In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems. Beyond these requirements, however, water users should be charged appropriately.

UNEP has also produced a number of specific technical reports on Cleaner Production and Environmental Management in different industrial branches.

10.2 Approaches to development projects for water management in the industrial sector

The different aspects of water management at industries and the examples and case studies given represent different opportunities for development support.

Possible approaches for cooperation include:

- **Strengthening of the legislative framework**. In many cases stringent laws exists but more detailed regulation or local by-laws needs to be developed to enhance regulatory incentives.
- **Capacity building of the public sector** in their role as regulators (monitoring and enforcement of laws). Even if a government bodies has been appointed as enforcers and monitors they many time lack the capacity to carry out their mandate. A capacity building project should ideally focus on practical on-the-job training. The industrial sector should also always be involved to ensure that they have the competence and commitment to carry out self-monitoring and adequate reporting.
- **Support to the industrial sector and its organisations** in managing and monitoring environmental protection. As outlined in section 8.4 this has proven to be a successful strategy in many cases and should play a part in many development projects.
- **Transfer of knowledge and technology for cleaner production**. Cleaner production can for some companies and in some circumstances be a compelling incentive in itself. However, these efforts must frequently be complimented by strengthening the regulatory incentives or supporting the industrial sector with more general training.
- **Demonstration projects** that serve as concrete examples are valuable aspect of development cooperation. A development project with a focus on institutional capacity building and training would also many times benefit from incorporated tangible and practical inputs such as demonstration plant.
- **Development of economic instruments**. This aspect has so far not played a major role in the direct support from Sida so far. Economic instruments such as water tariffs is however many times a pre-requisite for support from the World Bank and Regional Development Banks. Regulatory and enforcement aspects need also to be addressed to ensure the success of this approach.
- **Creating a participatory and informed constituency** through information and education to influence priority setting and support enforcement. This aspect can be the main focus or would at least form part of the approach to ensure a sustainable impact.
- **Incorporating water protection aspects in industrial development**. An effective approach is to make sure that issues pertaining to water use and pollution are addressed in all projects aimed at supporting industrial sector development.

- **Development of an Integrated Water Management Strategy**. Ideally the water management at industries should not be addressed in isolation but in an integrated strategy encompassing not only other sectors and water supply but also social, financial and resource issues in a broader sense.

This summary does not mean that these approaches should be implemented in isolation. On the contrary: in most cases the successful implementation of one approach would as indicated above rely on the successful development of one of the other.

When a project for industrial water management is being developed it is important to carefully analyse prevailing and potential *driving forces* for change. Indeed, this report can to a certain extent be seen as a presentation of potential driving forces: legal framework, economic incentives, industrial sector motivations, changes through public involvement etc. The fact that one of these driving forces alone can not be transformed into a sustainable change is the core of the argument in favour of broad projects including a number of different aspects and stakeholders.

As well as taking a broad approach to the goal of improved water management a project should ideally be open encompass other objectives as well such as poverty alleviation and gender equality. This will ensure that the stakeholders priorities are met and that the objective of equitable water access is put in a broader perspective.

Swedish institutions and companies have a broad and deep competence in this field, ranging from technical issues such as cleaner production to institutional aspects and social development. The possibility of Swedish development support along the lines presented in this report is therefore excellent.

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ANNEX 1

Examples of water pollution abatement in different industrial sectors

In this section, a selection of waste minimisation and mitigating measures are presented for a number of heavily polluting industrial sectors. The purpose of the presentation is just to give a broad overview of the work required to significantly reduce the industrial contribution to the adverse environmental impact.

Metal and Engineering Industry

This advice is suitable for the following industrial categories

- Iron and steel industry
- Metal plating and finishing industry
- Aluminium industry

Reuse of Chemicals

Anodising process
It is possible to recover sulphuric acid from anodising baths by using a retardation resin bed. The equipment functions as follows:

Sulphuric acid is retarded in the resin bed while the aluminium ion penetrates through the bed. The acid can then be washed out and restored to the anodising bath in a cyclic process. This process is not only resource conserving but also advantageous to the energy consumption. When the electrolyte reaches about 20 g Al/l the bath is unusable and has to be replaced. By the use of a retardation plant, the free sulphuric acid can be recovered and the energy consumption can be reduced at the same time.

Metal Plating and Finishing Process

The first step in chemical conservation is to reduce the drag-out quantities.

Most drag-out reduction methods are inexpensive to implement and can be justified on the basis of savings in chemical costs alone. In addition, pollution control savings are many times the cost of the changes.

The amount of pollutants contributed by drag-out is a function of such factors as the design of the racks or barrels carrying the parts to be plated. For years, wetting agents have been used in process baths to aid in the plating process. These substances are used, for instance, in bright-nickel plating to promote disengagement of hydrogen bubbles at the cathode. They are also used as an aid to drag-out reduction. The addition of very small quantities of surfactants can reduce surface tension by two-thirds with a proportional reduction in drag-out.

Several rules apply to the positioning of work pieces on plating racks for drag-out minimisation. The basic principle, however, is that every object can be positioned in at least one way that will produce the minimum amount of drag-out.

A drain board is one of the simplest methods for drag-out recovery. The drain board can capture drips of plating solution from racks and barrels. Drain boards not only save chemicals and reduce rinse water requirements, they also improve housekeeping by keeping the floor dry.

Chemicals in drag-outs from a process bath (e.g. nickel bath, hard chromium bath etc.) can be recovered in many different ways. The simplest and most convenient way is to arrange one or more drag-out tanks. The drag out tank is a rinse tank or a tank used to make up evaporative losses from the process and recover a portion of drag out chemicals for return to the process bath. The use of a single drag out tank will generally reduce the chemical losses at as much as 50% or more.

Metal Recovery Systems

Metals can be recovered from spent plating solutions, drag-out tank solutions and also from eluate emanating from ion exchangers by using electrolyse.

Electrolyse is also one way to reduce the production of metal hydroxide sludge. For valuable metals such as copper, nickel, silver and noble metals the electrolyse can be feasible from an economic viewpoint.

Reuse of Rinse Water

Diluted rinse waters can be purified in an ion exchange system. Water from the rinse bath is circulated over a strong acid (cation) and a strong base (anion) ion exchanger. Before installing an ion exchange system measures to reduce drag-out of process solution should be taken. It is also strongly recommended to add one or more drag-out tanks in the plating line.

A treatment system comprising drag-out tanks, ion exchanger and electrolyse can be supplemented with a vacuum evaporator in order to achieve a closed water system. The condensation from the evaporator can be used as make up water in the drag-out tanks.

Minimising Rinse Water Consumption

The wastewater management practices of the metal industry today can be broadly characterised as "end-of-pipe" treatment, discharge and disposal. High water usage has historically been the easy answer for a wealth of metal finishing challenges. High water usage has become an extravagant misuse of resources that is accepted as an unavoidable part of cost of doing business. Poor housekeeping practices resulting in spills and overflows constitute a double expense in the replacement of lost material and the treatment and disposal of the material that is sent to the wastewater treatment system.

Besides reduction of drag-out losses which gives an indirect lower need of rinse water, a counter-current rinsing system is the best way to minimise the rinse water flow at a sustained rinse criterion. Counter current rinsing takes advantage of multiple stage counter-current process operation to improve rinse efficiency. Counter-current rinse systems can be composed of several rinse tanks alone or in combination with spray rinse stations overhead.

Dairies

Water conservation programmes should be given priority, but may sometimes conflict with requirements for food preparation hygiene.

The quantity of wastewater and pollutants may be reduced by taking various steps. The plant pipe systems and other process equipment, as well as the process, should be designed so that product spillage and pollutants are minimised, or if possible recovered.

Emissions to water

Wastewater from dairies contains organic material and cleaning agent residues. Concentrations and composition will vary, depending on the size of the plant and the focus of production, among other

things. Where a large number of different products are manufactured the changes from production of one product to another means that there is a risk that there will be larger quantities of oxygen-consuming material and waste water than where the number of products manufactured is limited.

Purification by separation gives rise to separator sludge. Separators are usually self-cleaning and do not produce solid sludge. The sludge is flushed out of the separator into the wastewater network at predetermined intervals during operation, and also during rinsing before washing. This thin-bodied sludge contains 95 per cent water, and an estimated bio-chemical oxygen consumption of 30 kg BOD_7/m^3. Around 1,3 litres of sludge is produced per cubic metre milk.

The manufacture of edible fats may give rise to large concentrations of fat in the wastewater. Varying quantities of whey residue and cheese sludge enter the wastewater as a result of cheese production.

Table 3.1 Normal values for wastewater from dairies.

Parameter	Concentration (mg/l)
BOD_5	450–3000
Suspended solids	100–1000
Phosphorous, total	10–70
Nitrogen, total	15–250

The quantity of wastewater should not exceed 1–3 m^3/ton of incoming milk.

The water flow and quantity of pollutants varies greatly from one time to another during a 24- hour period. The pH of the water also varies enormously, as a consequence of discharges of acid and alkaline cleaning solutions taking place at various stages of the production cycle.

Dairies with modern equipment produce a specific wastewater quantity in the order of 1—2 m^3 of incoming milk delivered.

Plants producing cheese, edible fats and other products often use more water; around 2—3 m^3 /tonne of incoming milk delivered, giving rise to an annual mean load of 1—5 kg BOD7 /ton of incoming milk delivered.

A fat content in wastewater in the order of 45—230 g fat/in^3 has been reported.

The variations in water consumption and level of pollution are to a great extent due to local conditions relating to equipment and the focus of production etc, for which reason an assessment must be made from case to case.

Remedial measures

Wastewater from dairies is suitable for combined treatment with municipal wastewater. If the proportion of water from the dairy is very large, however, sludge bulking problems may arise. The effect of sludge bulking on wastewater treatment is that large quantities of filamentous bacteria are formed. The sludge then has very poor sedimentation characteristics.

CIP-system[1] should be adjusted so that discharges and load is thereby minimised. As much as possible of product/water mixtures should be recovered. Mixed milk and water with a dry solid concentration of more than 4% can be used directly as animal feed. Lower concentrations can be

[1] CIP is an abbreviation of Cleaning In Place (automatic cleansing system for pipes and equipment).

increased by addition of milk powder. To switch between product and the mixture product/water conductivity meter or a turbidity meter can be used.

Cleaning of dairies interiors and equipment should, as much as possible be done with high-pressure units or similar equipment. Cleaning agents and methods that have least possible effect on the environment should be chosen.

Hazardous chemicals used in the production should be substituted by less harmful ones if possible without affecting the process in a negative way.

Wastewater from dairies is easily broken down by biological treatment. With a degree of internal pretreatment, it should normally be possible to pipe such water to the municipal wastewater treatment plant. When designing the plant the pipe systems and other process equipment, as well as the process itself, should be designed so that product spillage and pollutants are minimised or, if possible, recovered.

At a properly running milk and cream dairy a figure of 1.0–1.5 kg BOD7/tonne of incoming milk delivered may represent a reasonable annual mean value. In the case of cheese and butter manufacture, the load will be somewhat higher.

The first butter rinsing water must be collected and dealt with. Sometimes the water is recirculated during the day, before being mixed in with the buttermilk. No butter rinsing water is produced at modern plants employing continuous churning.

In some cases there may be requirements concerning emissions of nitrogen and/or phosphorus. An example of such a requirement might be an annual mean value of 25 g Tot-P/tonne of incoming milk delivered.

If the wastewater is piped to a small treatment plant, or one working to full capacity, or if the dairy wastewater represents a large proportion of all wastewater treated, flow adjustment and pH adjustment should take place before the wastewater enters the wastewater network.

It is easy to believe that pH could be adjusted while the water is on its way to the municipal wastewater treatment plant. But a discharge of sodium hydroxide (lye), for example, has a tendency to continue as a single surge all the way to the treatment plant, where it then impairs the biological processes and/or causes major interference to the chemical precipitation stage. Common requirements for internal treatment include a flow-adjustment tank with pH adjustment.

Fat separation is normally a further requirement where curdling and churning takes place.

Breweries and Soft Drink Manufacturing

The first order priority should be to take internal measures and to implement current technology in order to minimise the water consumption/wastewater generation and the waste production to the following level:

Water consumption 3 – 5 m^3 per m^3 product (including cooling water).

Table 3.2 Targets for Specific pollution figures, Brewery and Soft Drink Manufacturing

Parameter	Breweries	Soft drink factories
BOD_7	4–5 kg/m^3 product	1–2 kg/m^3 product
COD	10–13 kg/m^3 product	
Phosphorous	0.03 kg/m^3 product	

Quantities of wastewater and pollutants can be reduced by taking various steps. The amount of wastewater, for example, can be reduced by introducing the CIP system, by using a high-pressure cleaning unit and by fitting the flushing hoses with self-closing nozzles.

One way of reducing the quantity of pollutants in the wastewater is by recycling the product to the process, e.g. last runnings and overspill beer from bottles not completely filled. Careful collection of concentrated spillage, e.g. spent hops, grains, sludge, surplus yeast, kieselguhr and label sludge, is important.

The second order priority should be to establish an efficient pre-treatment comprising at least screening/pre-settling, equalising and pH-adjustment.

Slaughterhouses

From an environmental viewpoint, the first order priority should be the discharge of organically polluted wastewater. Concerning this issue, it must be emphasised that a lot of efforts, by taking in-plant measures, should be made in order to decrease the waste discharge.

Water conservation programmes should be given priority, but may conflict with requirements for food preparation hygiene.

Cleaning of slaughterhouse interiors and equipment should, as much as possible be done with high-pressure units or similar equipment. Hazardous chemicals and cleaning agents should be substituted by less harmful ones.

It is especially important that as much blood as possible is collected for further refinement. Other blood waste should be collected and processed, for example as animal feed or fertiliser.

Chemical Industry

Minimisation of the discharges to water is made by careful emptying of mixing tanks and filling stations before washing. One should also consider the possibility of mechanical pre-cleaning. The internal wastewater treatment should include mechanical separation, equalisation of flow and concentration before discharge to the municipal wastewater treatment plant.

It is also advisable to restrict the use of certain surfactants as some alkyl phenol ethoxylates, which are degraded to toxic substances.

Textile Industry

Internal treatment by coarse screen, sedimentation, flow equalising and pH-adjustment before discharge to a municipal wastewater treatment plant. Machines using small quantities of water or chemicals (counter current rinsing and micro screening). It is strongly advised to put a lot of stress on the replacement of chemicals hazardous to the environment. The following list comprises substances that are recommended to be substituted.

Alkyl phenol ethoxylate
Dekabromo diphenyl ether
Dichloro toluene
Phthalates
CI Pigment Violet 23 (carbazole violet)

Chloro benzo triazole derivate
Chloro paraffins
Petroleumbased oil
Sodium cyanide
Sodium hypochlorite
Sodium sulphide
Organic tin compounds
Tetrachloro ethylene
Trichloro benzene
1, 1, 1-trichloro ethane

Trichloro ethylene

Many options concerning waste minimisation actions are available. As examples of improved house keeping measures the following can be mentioned:

- Collection of spills and leakages
- Avoiding overdose of chemicals
- Recycling of sodium hydroxide by evaporation and flotation
- Ultrafiltration of dyeing effluent
- Use vacuum technique to dewater fabrics, which minimise the carry over
- Use modern machines – jet machines do not need carriers

Tanning Industry

From an environmental viewpoint, the first order priority should be the treatment of chromium and organic containing wastewater. It should also be mentioned that a lot of efforts, by taking in-plant measures, should be made in order to minimise the generation of waste. It is important to segregate different types of wastewater, e.g. chromium containing, sulphide etc. The pre-treatment of the separated tributary streams should comprise at least screening/settling, sulphide oxidation, chromium precipitation and removal, equalising and pH-adjustment. The pre-treatment can be supplemented by chemical precipitation, which can improve the removal of suspended matter, and thus lower the discharge of organic material as well as heavy metals.

The following general recommendations should be regarded when assessing a tanning and leather finishing plant.

- Replace two-bath hexavalent chromium process with trivalent chromium single bath
- Improve fixation of chrome and implement chrome recovery
- Recycle spent chromium liquor to the tanning process or to the pickle vat
- Examine alternatives to chrome tanning such as titanium and aluminium
- Use salt or chilling methods to preserve hides instead of persistent insecticides and fungicides
- Reduce quantities of salt used for preservation
- Use non-organic solvents for dyeing and finishing

- Precondition hides before vegetable tanning

Through good management water use can be reduced by 30 –50% to 25 l/kg raw material. In areas with extreme shortcoming of eater even lower specific consumption has been observed (see for example "Environmental Assessment of the Bolivian manufacturing Industry – A Programming Study, SWECO International", 1995 where the average consumption of eight tanneries in the Cochabamba region was 17,6 m^3/ton raw hides).

These actions should include at least the following:

- Monitoring and control of process waters (50% reduction possible)
- Batch washing instead of continuous washing (50% reduction possible)
- Use drums instead of pits for immersion of hides
- Reuse wastewater for washing (e.g. Return lime wash water to soaking stage)
- Substitution of 100–250% floats by 40–80% floats (reductions up to 20% possible)

Waste reduction measures should include the following:

- Recover hide trimmings for use in the manufacture of glue, gelatine and similar products
- Recover grease for rendering
- Recycle sulphide in spent liming liquor after screening (sulphide loss could be reduced by 20–50% and lime loss by 40–60%)
- Use tanned shavings in leather board manufacture
- Control odour problem by good housekeeping, such as minimal storage flesh trimmings and organic material
- Apply to the *substitution principle* (organic solvents, dyestuffs etc.)

Table 3.3 Reduction targets per Unit of production (According to World Bank guidelines. The figures are the waste loads arising from the production processes before the addition of pollution control measures)

Parameter	Maximum value (Kg/ton raw material)
BOD_5	30 (1000 mg/l)[a]
Oils and grease	13 (430 mg/l)[a]
Chromium	0,6 (20 mg/l)[a]
Solid waste	560
Liquid effluents	25–30 m^3/ton

Treatment of tannery wastewater is always required

Segregation of different waste streams are always required:

- Soaking liquor (very high in salinity)
- Sulphide rich lime liquor

- Chromium containing wastewater

Pre-treatment could consist of:

- Screening (always necessary)
- Equalising
- Chemical precipitation (pH-adjustment, flocculation, settling to remove chromium and a large portion of organic material, BOD/COD)

Final biological treatment is normally required (in-plant or as a minor part of domestic sewage treatment)

Table 3.4: Effluents from Tanning and Leather Finishing Processes (According to WB guidelines. These requirements must be met in all WB financed projects).

Parameter	Maximum value
pH-value	6–9
BOD_5	50 mg/l
COD	250 mg/l
Total suspended solids	50 mg/l
Oils and grease	10 mg/l
Sulphide	1,0 mg/l
Chromium, hexavalent	0,1 mg/l
Chromium, total	0,5 mg/l
Coliform	400/100 ml

Solid waste must be disposed of in a secure landfill. Treatment typically adds 5% to the cost of production.

ANNEX 2

Checklist for project design: Management of water and wastewater in industries and small scale enterprises

The following checklist is meant a supporting instrument in the design or rapid assessment of projects related to water management in the industrial sector.

A checklist can of course never serve as complete guide but rather as reminder of key issues. It is important to keep in mind that there are a number of approaches to developing projects in this field (see chapter 10) and that a list of this kind should never hamper development and creativity in the project design process.

The list could be used as a complementary tool in the LFA process and as a supplement to Sidas already existing checklists for EIA in development projects.

Many of the recommendations of this report are arguments in favour of a broad approach; broad in terms of objectives, stakeholders, driving forces etc. This checklist could therefore be seen as a challenge to expand the scope and approach of projects.

Objectives

Objectives of Sida funded projects are generally set with a LFA process. The following points are reminders of issues with could be included in the formulation of a project in this field:

- Is the issue of water use addressed in a broader context, taking other end users into consideration such as:
  - municipal and rural water supply
  - agriculture
  - fishery
- Have objectives related to water pollution been set in relation to other discharges such as sewage treatment plants and agriculture discharge.
- Has the value and cost of water been addressed in the formulation of project objectives
- Have the measures to reach the overall objectives been subject to a financial analysis comparing them with other options.
- Is the measures to enhance water management at industries put in a broader environmental context (see technical issues)
- Does the project objectives include other goals related to social issues such as:
- Gender aspects
- Poverty alleviation

Stakeholders

The number of stakeholders should ideally be made broad since, as concluded in this report, many different sectors are required for sustainable improvements.

Which of the following categories have been included in project preparation and implementation:

- National Government Agencies or Ministries responsible for environmental protection
- National Government Agencies or Ministries responsible for industrial development
- Local governments responsible for environmental protection
- Government agencies (local and national) responsible for water supply
- Individual industries
- Industrial organisations such as chambers of commerce
- Representatives from the agricultural sector
- Affected communities and citizens in the project area.
- Organisations representing the public such as CBOs or NGOs

Driving forces

In this section of the checklist the driving forces for sustainable development towards the project objectives are dealt with on two levels:

1. Checklist of possible driving forces (main points)
2. Checklist for foundations or alternatives for each driving force (sub-points)

Which driving forces will be the primary foundation for a sustainable change in the project context?

- Government legislation and monitoring

If yes, have the following aspects been analysed and found adequate, or will their strengthening be part of the project objectives:

- The legislative framework
- The national process for EIA and environmental permits
- The capacity for local government follow-up and monitoring
- The role and capacity of the industrial sector in self-monitoring
- Industrial sector incentives

If yes, will they be based on:

- Trade and supply side incentives
- Internal Environmental Management Systems
- Increased capacity to meet existing goals and legislation
- Win-win options through cleaner production
- Economic incentives and disincentives

If yes, have the following fundamentals of implementing economic instruments been analysed and found adequate, or will they be addressed within the project framework:

- Legal basis
- Institutional framework
- Instruments for enforcement
- Consensus among stakeholders
- Public involvement

Technical issues

When technical aspects are included in the project the following questions apply:

- Has the generation (and subsequent management) of solid waste from wastewater treatment been addressed from an environmental and financial perspective.
- Has environmental and financial aspects of energy consumption related to water management been incorporated in project analysis and design
- Has the possibilities of cleaner production been taken into consideration.

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