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GUIDELINES, METHODOLOGY AND CONTENT OF A PRE-INVESTMENT STUDY IN A "HOT SPOT" AREA

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EXECUTIVE SUMMARY

For the preparation of pollution control measures in hot spot area, concrete projects have to be formulated according to precise technical, environmental and economical specifications.

These specifications should be defined after careful evaluation of technical alternatives which are applicable for the reduction of pollution loads caused by the existing sources in the hot sport area.

In order to concentrate the available financial resources to those sources with the highest polluting potential, a methodological approach has to be developed, which allows the classification of pollution sources and the prioritization of amelioration measures to be defined. For this purpose, a pre-investment study has to be conducted, which is an essential tool to be used by decision makers (national/regional authorities, financial institutions), in order to assess the impacts caused by pollution sources and to define relevant amelioration measures.

This document contains the major methodological steps and the factors/parameters to be considered for the preparation of these pre-investment studies. It is mainly focusing on liquid wastes caused by municipal (settlements, touristic enterprises) and industrial activities, which directly or indirectly are discharged into the Mediterranean Sea.

For the prioritization of pollution sources within a hot spot area, certain evaluation criteria are applied, which, after the identification of pollution loads and assessment of relevant environmental impacts, allow the ranking of these sources according to their significance. Then an evaluation procedure is presented, aiming at the assessment of consequences of various pollution control methods, which can alternatively be applied for each selected pollution source (i.e. treatment plants, clean technologies, recycling techniques).

At the end of this process, elements for concrete project formulation are provided, which describe the content of the necessary technical, environmental, organizational and economical specifications. These specifications form the basis for investment planning and for the forthcoming detailed studies (engineering, detailed cost/benefit analysis, etc.).

It must be emphasized that this document is outlining the framework and the content of a pre-investment study, without providing detailed technical descriptions of procedures, design methods, etc., which can be found in several excellent technical references. Its real value can hopefully be judged when the first of these pre-investment studies will be elaborated according to the methodology presented here.

I. GENERAL INTRODUCTION

In the context of the development of a Strategic Action Programme (SAP) for combating land-based pollution in the Mediterranean, an activity for the identification of pollution hot spots was launched by UNEP/MAP and partly financed by the Global Environment Facility (GEF), in order to assess the main pollution sources in the Mediterranean basin. The first phase of the activity was completed in 1997 with a preliminary assessment of the current situation in each participating country.

One of the major recommendations evolving from this phase asks not only for a more in-depth knowledge and evaluation of pollution loads causing severe adverse effects in the Mediterranean basin, but also for planning and realization of relevant amelioration activities.

As a result, a follow up project, cofinanced by GEF, was launched in 1998 related to the further implementation of the SAP. A major component of the project covers work on pollution hot spots and foresees the preparation of pre-investment studies in selected hot spots, which will guide decision makers to select the appropriate alternatives for pollution control and to plan future investments for concrete projects.

This document, which was prepared by a consultant to MAP, Mr Dimitris Tsotsos, contains methodological guidelines required for the preparation of pre-investment studies in hot spot areas. It is mainly focusing on the development of prescriptions required for project formulation for pollution control in a hot spot area (i.e. a gulf).

For the identification of these projects, a targeted approach has been adopted, aiming at the classification and ranking of pollution sources and of technical alternatives by applying weighted criteria. These criteria reflect the relative contribution of various sources to the total polluting load in a hot spot area as well as the potential of relevant alternatives-options to reduce the load.

For the preparation of the document, the following assumptions have been made :

- users are familiar with the technical content of methods and procedures mentioned here (environmental impact assessment, rapid assessment, treatment processes etc.)
- detailed technical data have to be collected from relevant literature references
- this guide presents the main points of methodological concepts and procedures to be considered for the elaboration of the pre-investment study and not excessive description of relevant contents.

II. SCOPE-OBJECTIVES OF A PRE-INVESTMENT STUDY

A pre-investment study is the intermediate step between the preliminary assessment of existing conditions within a study area and the detailed studies required for the realization of investment (engineering studies, construction plans etc.). It is a basic decision support tool to be used by national / regional authorities, financial institutions as well as by the public opinion for the identification, assessment and evaluation of impacts caused by various pollution sources and for the definition of relevant amelioration projects.

It should also show the costs and benefits of each project to be formulated and to define the accompanying measures (organizational framework, financing etc.) required for plant's operation.

For the formulation of concrete projects the technical, environmental, organizational and financial specifications have to be prepared, which is the major content of the pre-investment study. These specifications form the basis for the detailed system design, engineering studies and organization of financial arrangements which have to follow at a later stage.

A pre-investment study should assist the decision making process for targeted investment planning. Therefore decision makers have to be provided with :

1. a list of classified pollution sources within a hot spot area
2. ranking of pollution sources for setting priorities for investment
3. description of alternatives-options of amelioration activities
4. environmental, technical, organizational and financial specifications of projects to be formulated and financed.

III. CLASSIFICATION-RANKING OF POLLUTION SOURCES

Introduction

Several pollution sources within a hot spot area contribute with their effluents to the deterioration of the quality of the water recipients. Effluents reach the sea water, which is of premium concern here, either directly (outfalls) or indirectly (via rivers, creeks etc., leachates through soil).

A pollution control programme should, theoretically, tackle all sources at once despite their significance and size, in order to achieve the best possible results. This can be done by applying environmental legislation (compliance-enforcement of effluent standards) to all polluting enterprises.

Nevertheless, when it comes to decisions for environmental investments, a more targeted approach is always required, which should combine the optimum use of financial resources with a high degree of environmental protection.

Within the objectives of a pre-investment study, a classification and ranking of pollution sources is a fundamental basis on which concrete project formulation should be based.

In this chapter a methodological approach for this classification is presented : after the identification of pollution loads and the assessment of environmental impacts, the application of certain criteria allows the classification of pollution sources according to their significance. As a consequence, a list of ranked pollution sources can be submitted to decision makers for targeted planning of investments.

The rationale behind this method is that concentration of resources for pollution abatement measures finally leads to better environmental results than funds scattering for all pollution sources.

1. Identification of pollution loads

1.1. Definition-classification of sources

Within a hot spot area a rapid qualitative inventory of all point sources has to be elaborated be reviewing existing archives / records.

These pollution sources are classified as municipal (settlements, touristic units) and industrial. Commercial activities, usually small scattered sources within an urban area, are not considered, whereas pollution caused by agricultural activities cannot be assessed in the framework of this document.

The main waste streams can be classified as follows :

settlements (municipalities)

- **liquid** (sewage, leachates from garbage disposal sites)
- **solid** (garbage, sludge from wastewater treatment plants)
- **air emissions** (traffic, central heating)

industries

- **liquid**
- **solid**
- **air emissions**

Within the context of this study major importance should be given to liquid wastes and secondarily to solid wastes (floating materials, leachates reaching water bodies), whereas only ins special cases (i.e. large amounts of particulate emissions) air emissions may affect water quality.

Mapping of relevant municipal and industrial enterprises and on-site visits allow a first visualization of source positioning in the area.

1.2. Source inventory

Liquid and solid wastes from all polluting activities within an identified enterprise must be quantitatively assessed, in order to evaluate each source's contribution to total pollution load within the hot spot area.

Several methods for source inventory are in practice, which provide different results according to set objectives and available data. Environmental information is therefore of great importance but is sometimes either non-existent or in inappropriate forms.

Rapid assessment is a technique based on the documented information on pollution sources from each kind of activity (i.e. industrial branches). It requires indicators of consumption and outputs for processes which, when multiplied by tested waste load factors, provide reliable estimations of pollution loads. Its validity depends entirely on the waste load factors, which usually are derived from statistical interpretations of known, similar sources. It is a simple method, easy to use and may act as a first step towards an inventory process. More details can be found in the literature.

Environmental auditing is a method asking for in-depth examination of processes according to internationally prescribed procedures (ISO 14000, EMAS etc.). It requires data research of existing records and eventually production of new monitoring data (sampling-analysis) in order to thoroughly assess not only waste streams but also the enterprise's environmental management performance.

Practical application of both methods requires the preparation of questionnaires and checklists, which will be used by the working team during on-site visits and inspections.

The most accurate method is direct monitoring of waste sources, which, nevertheless, is extremely time consuming and resource intensive, particularly for industrial wastes. It requires careful sampling and laboratory analysis to determine concentrations of pollutants, which have to be known for the design of pollution reduction measures.

For optimum results a combination of these inventory methods is recommended, where sampling/analysis requirements are targeted to specific parameters and selected check points of processes, which are defined during rapid assessment / environmental auditing application phase.

1.3. Review-examination of standards

Setting of effluent standards has to take into consideration some factors, mostly depending on the receiving water quality. As a general rule, the combined load of discharged effluents within an area should never exceed the self-purification capacity of water recipients.

Existing standards provide the legislatively obligatory basis for polluting enterprises to comply with. They have to be reviewed and eventually amended in scientific (i.e. too strict in relation to the actual self-purification conditions or receiving waters, "wrong" parameters characterizing effluents from certain industrial processes etc.) and political-administrative (i.e. limited resources of small-medium enterprises to apply pollution control measures, local population pressing for stricter regulations etc.) terms.

Final concentrations of key parameters of examined waste streams have to be compared with these standards in order to assess the degree of compliance and eventual deviations. These deviations form the first indicators of the magnitude of problem to deal with.

1.4. Classification of waste streams/loads

For each pollution source within the hot spot area, all waste streams and relevant loads are listed and quantitatively assessed according to the methods described above.

They should be ranked according to the waste quantities produced and the degree of deviation from effluent standards. For that purpose figures expressed in load discharges (i.e. tn BOD5/day) should be preferred to those in final concentrations of pollutants, since they present a clearer picture of the polluting activity.

This classification of loads will be used as basis for the evaluation of the effects caused by relevant pollution sources (Chapter 3.1.).

2. Environmental impact assessment (EIA)

The identification and classification of waste streams is one of the prerequisites to proceed with the elaboration of an EIA study for each pollution source. This study will enable the identification, prediction and interpretation of potential impacts on the environment and especially on receiving water quality.

There are several methods applicable for EIA-elaboration varying in the degree of quantification of impacts and accuracy of predictions. This task is more complex for industrial activities with the large variety of production processes, whereas more standardized procedures are applicable for municipal sources (settlements, touristic units, landfill sites).

Detailed description of methods for EIA-preparation can be found in the literature. An example of UNEP's simplified EIA-procedure is presented in Annex II. Methodological aspects to be considered for the purpose of a pre-investment study are mentioned in section V (Chapters 1.2.2. and 2.1.3.) of this document.

The extent and degree of accuracy of an EIA-study at this stage has to be decided by the working team preparing the pre-investment study, according to available resources and time. It must be mentioned, that detailed assessment of environmental impacts has to be elaborated at a later phase, when concrete projects for selected pollution sources have to be formulated.

3. Ranking of pollution sources

3.1. Criteria of significance - a review

The hot spots ranking system, which had been used during the 1st phase of the activity (Annex I), contains the basic criteria to be also applied for the evaluation of impacts caused by pollution sources within the hot spot area. Nevertheless some of the numerical figures used for the estimation of the gravity of effects, namely wastewater loads and investment costs express the cumulative values from all sources in the area. As a consequence they cannot reflect the relative importance of each source and must be adjusted accordingly.

An adaptation of figures to the relative importance of each pollution source can follow the classification of loads presented in chapter 1.4. There are no fixed rules for setting values as basis for the evaluation of effects. These values can be determined i.e. as the numerical average of all organic loads in the area.

Consequently effects have to be classified as major, moderate and slight and only in exceptional cases, where figures approach the values presented in the aforementioned ranking system (i.e. > 15 tons BOD/day), severe and extreme effects should be considered.

By this analysis a flexible evaluation of effects caused by various pollution sources is achieved without abandoning the scientifically derived figures of the ranking system.

3.2. Specific criteria

To the basic criteria mentioned above, following factors have to be added, which cannot be neglected by the decision making process :

a) environmental criteria

- **preservation of existing biotopes**
- **specific conditions of water recipients** (i.e. eutrophication phenomena)

b) socioeconomic criteria

- **limited resources of enterprises to finance environmental investments**
- **inadequate administrative / organizational framework for the enforcement of standards**
- **pressure of local population for immediate actions**
- **on-going planned environmental investments in the area**
- **preparation of regional development plans, masterplans etc.**

The evaluation of these additional criteria, not necessarily expressed in numerical values, allows a better planning of investments and helps avoiding overlapping of programmes and wasting of resources.

3.3. Final ranking of pollution sources

Sources are ranked according to the scores achieved by the application of the described evaluation system. Based on this list, and also considering the qualitative criteria mentioned above, final decisions for priority investments will be drawn.

IV. AMELIORATION MEASURES - FORMULATION OF PROJECTS

Introduction

After identification and prioritization of the major pollution sources within a hot spot area, various amelioration measures have to be defined, in order to minimize the pollution loads caused by these sources.

The technical and organizational character of these measures has first to be clearly described, in order to proceed with the formulation of concrete projects (i.e wastewater treatment plants, landfill sites) needed for combating pollution from the hot spot area.

In order to achieve a rather precise formulation of these projects, careful evaluation of the consequences of various alternatives - options applicable for each pollution source has to be accomplished according to well defined criteria. The compliance of these alternatives with these criteria will enable decision makers to select those processes and methods which are required as basis for the final formulation of relevant projects. In order to access these consequences, the predicable impacts on the environment, public health, socio-economic situation for each alternative have to be accessed, as well as the technical and economic implications (i.e. operational simplicity, operational costs etc.).

As long as the methods for pollution reduction are selected, the technical specifications, the environmental performance, the operational characteristics and the organizational framework of each project have to be precisely estimated.

Cost indices such as investment costs, operational costs etc. have finally to be calculated and methods for financing and economical sustainability of the project have also to be recommended to decision makers and financial institutions. This part is strongly dependent on the prevailing legislative and organizational conditions in each country and has to be carefully considered in close cooperation with the relevant national and local institutions.

1. Identification - selection of alternatives

1.1. Systems for pollution control

Various treatment processes and systems for municipal and industrial wastes have to be considered and evaluated in order to access their applicability for each particular case. Detailed descriptions of these systems can be found in the literature and obviously cannot be covered by this methodological document.

For municipal liquid wastes (settlements - touristic enterprises), treatment methods are classified as physical (screening, grit/grease removal, primary sedimentation), biological (aeration & secondary sedimentation) and advanced (removal of nutrients). Disinfection is a method for the removal of microorganisms.

For industrial effluents, physicochemical (coagulation / flocculation - sedimentation) and in-site minimization methods (recycling of wastes within the industrial plant, clean technologies) have also to be considered as additional alternatives.

Uncontrolled solid waste disposal has to be controlled by sanitary and filling, waste incineration and dumping in carefully selected and controlled sites (i.e. old mines for toxic wastes). Recovery of by-products is linked with selected collection of garbage in cities and recycling techniques within industrial plants.

For each pollution source within the hot spot area, candidate alternative options based on these basic treatment methods, have to be defined and described.

Waste collection and final disposal systems for each option have also to be determined, in order to evaluate integrated solutions for each case. Combined sewerage networks for neighbouring communities or separate systems, reuse of treated effluents for irrigation and direct discharge into water recipients via submarine outfalls are some of the major alternatives to be considered for wastewater management.

1.2. Selection procedures

1.2.1. Introduction

The compliance of candidate alternatives with generally acceptable criteria will enable decision makers to select those methods suitable to each particular hot spot area according to the desired degree of environmental protection. These criteria combine environmental, hygienic, technical / economical requirements as well as local conditions, which cannot be neglected by the decision making process. They have to be categorized and classified according to the final goals and objectives set by managers and decision makers.

Each category of criteria can have a weighted (ranking) value, thus demonstrating its importance in the evaluation process, i.e. the compliance of an alternative with hygienic criteria is more important than its degree of operational simplicity (technical criteria).

This suitability of each alternative with each weighted criterion is expressed as numeric value (i.e. 4 - very good, 3 = good, 2 = moderate, 1 = poor), which has to be multiplied by the citerion’s weighted value. The final ranking of all alternatives is based on the achieved results of this weighted ranking analysis. The alternative with the highest score is the first choice for final selection.

For each alternative, the significance of its impacts on the environment, on public health and on local socio-economical conditions has to be outlined, in order to proceed with the evaluation of its performance and its compliance with the criteria. This impact assessment can be accomplished by any type of methodological tools at a rather qualitative extent at this stage. Obviously a detailed study of impacts with quantitative analyses and techno-economical proposals goes beyond the scope of this chapter by which the significance of those impacts is demonstrated. A detailed, quantitative assessment study has to be elaborated, when concrete projects for each alternative will be formulated.

One of these qualitative methods, UNEP/MAP/MAP-MAP (PAP/RAC) guidelines for environmental impact assessment, is presented in Annex II.

It must be emphasized that the requirements of this analysis go beyond the typical compliance of alternatives with locally applicable effluent and ambient standards: the compliance of final concentrations of effluents with legislative requirements is obviously a prerequisite for the evaluation of the alternatives.

1.2.2. Assessment of impacts - consequences of alternatives

1.2.2.1. Environmental impacts

Impacts caused by effluent discharge on :

- **the sea** (by submarine outfall)
- **nearby surface waters** (rivers, lakes, creeks)
- **groundwater** (storage reservoirs, underground disposal)

- **soil** (storage reservoirs, underground disposal)
- **plantation** (by irrigation)
- **Impacts caused by <u>sludge treatment / disposal</u> on :**
- **soil** (leachates from drying beds)
- **groundwater** (leachates from drying beds)
- **air** (odours)

Other impacts caused by <u>plant's operation</u> :

- **odours**
- **mosquito breeding**
- **noise**
- **traffic** (lorries discharging septage wastes)
- **impacts on landscape**

Impacts caused by <u>solid waste disposal / treatment</u> on:

- **the sea** (floating material from disposal sites, indirect discharge of leachates)
- **nearby surface waters**
- **groundwater** (leachates from disposal sites)
- **soil** (leachates from disposal sites)
- **air** (odours, emissions from incineration plants)

Other impacts caused by <u>sites'/plants' operation</u> :

- **mosquito breeding**
- **noise** (tracks)
- **traffic** (tracks)
- **impacts on landscape**

1.2.2.2.Public health risks

Public health risks are related to :

- **water quality deterioration** (effluent discharge / uncontrolled percolation of leachates into water bodies)
- **impacts on crops** (effluent reuse for irrigation, sludge as fertilizer / soil additive)

In both cases any risks for the population linked with drinking water supply, consumption of crops / fish, recreation (bathing, water sports) have to be carefully accessed and evaluated.

These health risks are caused by pathogenic microorganisms and toxic pollutants contained in insufficiently treated and disinfected effluents / leachates.

Methods for risk minimization have to be considered and evaluated relative to each alternative. Besides effective disinfection of effluents and collection of leachates from solid waste disposal sites, special care should be given to effluent storage / reuse for irrigation (deep reservoirs, subsurface injection, spraying methods etc.).

1.2.2.3.Socio-economic impacts

Any alternative for waste management has to be evaluated within the prevailing local socioeconomic conditions, which, in some cases, are of equal importance with pure technical and environmental aspects and can decisively affect the performance of concrete projects. In this context the reluctancy of local population to accept incineration plants for toxic wastes is a typical example occurring in some Mediterranean countries.

The following factors indicatively reflect some of the major social and economical conditions to be considered during the decision making process. They can be extended or modified according to the actual situation :

- **role of environmental protection for local economy** (i.e touristic activities require strict effluent standards)
- **land use planning** (i.e. limited space availability for treatment plants, inconvenient siting)
- **reforestation requirements** (i.e encourages wider application of irrigation methods)
- **existing infrastructure** (roads, bridges enabling access to plants)
- **administrative requirements** (i.e. establishment of new administrative units for plant's operation, amendment of legislative framework)
- **manpower requirements for plant's operation - management**
- **acceptance of alternatives by local population**

1.2.3. Definition of criteria

The selection criteria can be classified into categories and ranking values which represent their importance in the evaluation process. This importance can vary from case to case, according to prevailing local conditions. The following categorization demonstrates a typical balance among categories and values:

CATEGORY	RANKING VALUE
a) environmental criteria	
1.impacts on : sea water	8
2................. : groundwater	7
3................. : surface water	5
4................. : soil	4
5................. : air	3
6................. : landscape	3
7.conservation of resources	5
Total	**35**

b) hygienic criteria 8.injection risks for population 9.impacts on sea uses (bathing, fishing etc.) 10.groundwater contamination	 20 15 10
Total	**45**
c) technical / economical criteria 11.construction costs 12.operation / maintenance costs 13.land occupation	 4 6 5
Total	**15**
d) specific criteria 14.requirements for additional infrastructure, manpower, administration 15.acceptance of projects by the public	 3 2
Total	**5**

Explanations - justifications

a) Hygienic criteria are obviously of higher importance than all other criteria.
b) Preservation of sea water quality can have first priority in Mediterranean countries for touristic purposes.
c) Groundwater pollution can be of lower importance if water supply drills uptake water from deep aquifers, which are usually protected by stone layers. It can be scored higher in other cases.
d) Conservation of resources means effluent reuse (i.e. for irrigation), recovery of by-products etc.
e) Land occupation for plants is important in places where space availability is limited.
f) Requirements for infrastructure describes i.e. the eventual necessities for new access roads to plants.
g) Manpower - administrative arrangements refer to personnel hiring for plant's operation - maintenance, whereas new administrative units (i.e. sewerage companies) are needed for monitoring purposes etc.

2. Project formulation

Introduction

When the selection of alternatives is finished, concrete projects for each pollution source have to be formulated, which, at a later stage, will be constructed and operated. For each project (i.e. biological wastewater treatment plants for municipal effluents, sanitary landfills for solid waste, a cleaner technology for an industrial unit etc.) its detailed technical characteristics, operational requirements and environmental performance have to be clearly defined.

The environmental specifications are first described in this chapter, since they contain the specific requirements (i.e. degree of pollution reduction) needed to proceed with the technical design of the installations.

The organizational arrangements, which accompany the realization of any project (i.e. establishment of sewerage companies, hiring of personnel / training etc.) have also to be described, since they form the framework, in which the projects will be developed and operated.

A detailed cost analysis of all factors relative to project's realization has to be finally elaborated : costing of investment, of plant's operation / maintenance, of accompanying actions (i.e. costs for hiring and training of personnel). Based on the results of this analysis, methods for financing the relevant costs have to be proposed to decision makers.

It must be outlined that this chapter is the final result / "product" of all previous methodological steps and forms the basis of the formulation of the forthcoming investment studies, which will contain all engineering, cost / benefit and financial factors needed for the project's construction.

2.1. Environmental specifications

2.1.1. Performance requirements

In order to define the treatment efficiency of each project the following parameters have to be considered :

- **actual incoming pollution load** (waste quantities, main parameters)
- **existing / amended standards for disposal of treated wastes into the environment**
- **ambient standards** (water quality of recipient, water uses)

The desired degree of treatment efficiency according to set effluent standards is the main prerequisite which defines the technical process design of wastewater treatment plants for municipal and industrial effluents. The relevant effluent standards are usually set by the environmental authorities according to legislative requirements (i.e. EU-Directives), to prescribed criteria for specific uses of effluents (i.e. for irrigation) and to defined uses (i.e. bathing, fishing) of the water recipients. These standards have also to be followed by any discharge of leachates from solid waste landfill sites.

Examples of such criteria and standards are indicatively summarized in Annex III.

The quantities and the parameters of the incoming wastes are estimated (Section III, chapter 1) and measured at the outlet of the pollution source to be considered. Whereas effluents from municipal sources (settlements, touristic enterprises) can be easily estimated and measured, special care should be devoted to the measurement of industrial effluents which often are intemittently discharged into sewerage networks (batch processes) with varying concentrations.

2.1.2. Site selection

Several sites for plant positioning have to be examined, in order to finally choose the area causing the less harmful environmental impact. Topographical and morphological conditions often limit the availability of environmentally appropriate locations for plant siting, whereas strict water quality criteria (i.e. water uses for drinking water supply, bathing) and the related prescriptions for effluent standards are additional limiting factors for site selection.

2.1.3. Environmental impact assessment (EIA)

For each alternative site the careful assessment and evaluation of environmental impacts caused by plant's operation has to be conducted.

A study should systematically access all predictable impacts and formulate proposals for their monitoring and minimization. Its extent and context goes far beyond to the rather qualitative approach mentioned earlier (Chapter 1.2.2.), aiming at an in-depth knowledge of any eventual harms caused to the environment.

An EIA report usually contains the following :

- **description of the project and its activities**
- **description and evaluation of alternative sites with and without the proposed project**
- **reasons for selecting the proposed sites and project's technologies**
- **identification - assessment of anticipated / forecasted negative and positive impacts at the environmental conditions**
- **descriptions of measures proposed for eliminating or minimizing the adverse impacts**

Detailed methods for the quantitative assessment of environmental impacts based on simulation models, measurements etc. can be found in the literature and in computerized form as well and should be accordingly applied.

This detailed analysis allows the selection of the most appropriate location for each plant and enables decision makers to eventually modify and improve the technical specifications of the chosen alternatives. Therefore it is the most essential part in any decision making process.

2.2. Planning of projects

Introduction

This chapter deals with the identification of the main elements and factors needed to select and plan a technical system for waste collection, treatment and disposal. Inevitably short, it is not providing technical details which can be found in the relevant technical books and references.

Since a pre-investment study is focusing on systems selection and planning and not on detailed engineering designs, the scope of the analysis presented here is to identify the main parameters to be considered for the selection of processes and systems.

Due to the fact that direct effluent discharges into water bodies constitute the main pollution sources within a hot spot area, special attention is given to wastewater systems. Solid waste disposal sites only indirectly affect water recipients by uncontrolled discharge of leachates.

2.2.1. Waste collection - treatment

2.2.1.1. Municipal liquid wastes

The following parameters should be considered for collection systems :

- **design period** (population served, expected population growth, eventual connection of surrounding settlements and of industries)
- **wastewater characteristics** (parameters, quantities, eventual industrial discharges into the system)
- **design flow** (hourly / daily / seasonal variations, infiltration rate into the sewer, peak discharge at the end of design period)
- **type of sewer system** (combined or separate)
- **topography - morphology of the area**

Process selection and design for treatment systems has to consider the variety of methods currently applicable, in order to reach the appropriate combination of processes according to set treatment requirements.

In Annex IV an indicative list of operational characteristics of various treatment processes is shown.

Systems can generally be divided into 4 different parts namely :

- **physical treatment** (screening, grit removal, oil / grease separation, primary sedimentation)
- **biological treatment** (aeration & secondary sedimentation)
- **advanced** (removal of nitrogen and phosphorus)
- **disinfection** (removal of microorganisms)

For an optimum selection of the combination of systems the following parameters have to be considered :

- **design period**
- **wastewater characteristics**
- **design flow**
- **treatment efficiency requirements according to set effluent / receiving water quality standards**
- **cost factors** (investment costs, operation / maintenance costs)
- **simplicity of operation**
- **space availability**

For each process within the selected system, the design of the relevant unit operations follows certain parameters, which define the plant's dimensions and operational pattern. These parameters (i.e. aeration rate, sludge / volume loading, sludge volume index etc. for aeration plants) can be found in any environmental engineering book.

This process design is essential for the definition of all treatment units, the assessment of their site and a preliminary estimation of investment costs.

2.2.1.2.Industrial liquid wastes

Collection and treatment of industrial effluents depends on the specific characteristics of each industrial production process and the selected alternative for waste minimization.

Systems can be divided into two main parts : end-of-pipe, clean / recycling technologies.

The application of end-of-pipe methods requires mixing and collection of all effluents from an industrial unit, whereas waste segregation is essential for the installment of clean technologies at specific steps of an industrial production process.

The following aspects for end-of-pipe systems have to be considered :

- **collection system per industry** (units to be connected, eventual segregation of waste streams for in-site treatment, batch discharges)

- **combined collection system for more than one industries** (types of industries to be served, points of connection with the central sewer)

- **wastewater characteristics** (parameters, quantities, pretreatment requirements)

- **design flows** (batch discharges, variations, mixing of various waste streams)

- **treatment efficiency requirements** (direct discharge into water bodies, eventual connection with municipal sewer-treatment systems, pretreatment requirements)

For the application of clean / recycling technologies within an industrial unit it is essential to understand the production process to be tackled and the characteristics of the technology to be applied. The following factors must be assessed :

- **mass / energy balance of industrial process** (inputs-outputs of raw materials, chemicals, water, energy)

- **operational parameters of industrial process** (temperature, pH etc., existing electromechanical equipment)

- **waste characteristics of industrial process** (pollutants, quantities)

- **requirements for removal of pollutants according to set effluent standards**

- **characteristics of clean technologies to be applied** (type of installations, removal efficiencies, use of chemicals, water, energy, quantities of by-products, final effluents)

2.2.1.3. Solid-toxic wastes

Methods for selective collection of solid wastes (recovery / recycling of materials) can substantially contribute to reduce the final quantities to be treated and disposed. Special care should be given to the collection, storage and treatment of industrial toxic wastes, which have to be stored in sealed boxes marked with warning instructions and safety regulations.

Treatment can be accomplished in waste incineration plants (i.e. hospital wastes) or in landfill sites, which is the prevailing method for treatment and controlled disposal of municipal solid wastes in the Mediterranean countries.

Toxic wastes should be stored in special deponies (i.e.in old mines), where any leachate from the sealed boxes and eventual contamination of aquifers must be avoided.

Leachates from landfill sites have to be collected from the bottom of the sites and either separately treated or discharged into a municipal sewer network.

2.2.2. Disposal of effluents

2.2.2.1. Discharge into the sea

The discharge of effluents into a water body is the final link in the chain collection - treatment - disposal, whereas the preceding eventual errors and failures are clearly shown by the negative impact of the treated effluent on the water quality .

Disposal by marine outfalls is based on the processes of initial dilution, wastewater dispersion as well as on the biochemical processes of self-purification of sea water.

Planning of a technical solution requires the assessment of the following information:

- **preliminary data** (effluent characteristics, marine environment characteristics, water quality standards)
- **field measurements** (temperature, salinity, currents, conditions of benthic flora-fauna, sediment)
- **climatic, hydrological, oceanographical conditions** (rainfalls, flooding, wind directions, tides-waves)
- **geological, hydrogeological conditions** (rocky layers, supporting strength of the ground)

2.2.2.2. Discharge into freshwaters

Any discharges into rivers and lakes should be carefully planned and executed by considering the specific characteristics of each water body : small creeks-currents with strong variations of water flows cannot accept effluent quantities, whereas the limited self-purification capacity and the additional loading of lakes with nutrients from agriculture makes any decision for effluent discharge rather difficult.

Therefore careful and extensive assessment of the environmental, hydrological and hydrogeological conditions of rivers and lakes is needed before proceeding with the design of any disposal system.

Usually strict effluent / water quality standards are applicable for discharges into fresh waters, requiring advanced (tertiary) treatment methods and nutrient (N,P) removal.

Elements to be considered for disposal into lakes :

- **Stratification** (measurements of density, temperature)
- **climatic conditions** (temperature, winds)
- **hydrological conditions** (waves, currents)
- **flora - fauna**
- **environmental sensitivity** (assessment of pollution indicators like chlorophyl)

Elements to be considered for disposal into rivers :

- **degree of reoxygenation** (rate of re-aeration, dissolved oxygen deficiency, algal population, rate of photosynthesis - respiration)
- **degree of deoxygenation** (ultimate BOD at discharge point, sludge deposits on the bottom / benthic layer)
- **physical conditions** (velocity, turbulence)

Use of oxygen-sag models are widely applied, in order to assess rivers’ capacities for effluent acceptance. The calculations and assumptions for model running can be found in the literature.

Use of diffuser systems is recommended, in order to prevent foaming during effluent discharge.

2.2.2.3.Discharge into estuaries

The zone in which a river meets the sea is defined as estuary. Its analysis is more complicated than the analysis of rivers or lakes.

Some important parameters to be considered for effluent discharge are here mentioned :

- **degree of lateral mixing** (ebb-flow of tides)
- **stratification of estuarine waters**
- **assessment of physical conditions** (flow processes)
- **dispersion of effluents**

Mathematical models are also applied for the assessment of the processes occurring by effluent disposal into estuaries.

2.2.2.4.Reuse of effluents

Irrigation of fields with treated effluents is an attractive alternative avoiding any adverse effects on water recipients and encouraging conservation or resources. It is linked with storage requirements of effluents, when demands for irrigation are lowered (during winter).

Groundwater recharge and subsoil injection are also used with the latter being applied in coastal areas, in order to prevent sea water intrusion into the aquifer.

Several aspects have to be carefully evaluated for the safe application of reuse methods, namely:

- **hydrogeological conditions** (soil nature / thickness, groundwater level, degree of effluent percolation through the soil)
- **crops to be irrigated** (restricted / unrestricted irrigation, period for irrigation)
- **compliance with safety regulations** (WHO-recommendations)
- **selection of irrigation methods** (non-spraying techniques)
- **land requirements**

2.2.3. Treatment-disposal of sludge

There are several treatment and disposal methods for effective sludge management such as thickening, stabilization, conditioning etc. which are extensively described in engineering books.

It is obvious that any sludge dumping into the sea must be avoided, whereas leachates from sludge disposal sites have to be collected and discharged into the wastewater treatment plant.

Dewatering-disposal of sludge in drying beds is the usual case in Mediterranean countries whereas leachates reach the water bodies. This method is used for rather small communities and produces stabilized sludge. Special care should be devoted to the construction of the leachate collection system under the bottom of the beds, which has to cope with rainfalls and consequently with larger leachate quantities.

2.3. Design, construction and operation of plants

After systems planning, preliminary design of all processes and unit operations of the plants has to be elaborated, to be approved by competent authorities for works authorization.

The design deals with the technical aspects of the decided project containing all necessary data for its evaluation, such as :

C **flow diagrams**

C **process design**

C **operational characteristics**

C **construction - operation aspects**

etc.

In Annex V the format of such a preliminary design report for a wastewater treatment system is given.

This design is the bridge between the general process planning and the final engineering studies which contain all technical details needed for construction purposes (maps, graphics, calculations, materials, costs, etc.).

It enables decision makers to understand some of the practical aspects of project's realization and to access the major costing factors.

These major practical aspects are presented in this chapter. They are focusing on process analysis, equipment, operational requirements.

2.3.1. Process analysis

For a detailed analysis of all processes involved some fundamentals have to be prepared such as :

C **process flow sheets** (schemes / functions of unit operations)

C **definition of design criteria** (size determination of facilities)

C **mass balance** (inputs-outputs of solids, chemicals etc.)

C **hydraulic profile** (determination of hydraulic gradient within a plant)

C **selection - design of reactors** (batch, plug-flow etc.)

After sizing / dimensioning of all process units the plant layout has to be prepared, namely the location of facilities and buildings. The following aspects have to be considered :

C **geometry of site**

- **topography**
- **soil-foundation conditions**
- **location of influent sewers**
- **location of discharge point**
- **transportation access**
- **additional area for future plant expansion**

2.3.2. Equipment

Selection of equipment for each process has to follow certain rules which substantially determine the plant's performance during continuous operation. It must be emphasized that plant failures are rarely caused by wrong design of unit operations (i.e. undersizing of units, bad estimation of flows etc.), but usually by equipment malfunctioning.

There are some important principles to be followed by design engineers by choosing equipment and construction materials, namely :

- **durability - resistance to chemicals**
- **safe and simple operation**
- **environmental suitability** (i.e. noise control)
- **costing** (balance between purchase and maintenance costs)

Specific requirements (i.e. use of surface aerators or diffusers for aeration) have to be solved by the preparation of the engineering studies according to the prevailing local conditions and to purchase offers.

2.3.3. Operation - maintenance (O/M)

The reliable operation of plants can be planned during the design phase and the preparation of plant realization (engineering studies). A well-prepared O/M programme can conserve capital, manpower and energy. This programme is closely related to the selected processes and equipment as well as to the operating personnel.

A manpower plan should foresee managers and operators, analysts-chemists for laboratory analyses, technicians for mechanical and electrical workshops as well as stand-by personnel for all types of emergencies.

Training can be accomplished in specialized schools and on-spot (short courses). Certification of qualified personnel should be encouraged.

Safety-occupational health regulations have also to be prepared before plant's operation. Special care should be devoted to areas where chemicals are used (flocculants / coagulants, disinfection agents etc.), where specifications for minimization of hazards (leakages, air emissions) should prescribe the operational conditions, storage requirements etc.

For drafting these regulations, international (i.e. WHO) recommendations and national prescriptions have to be taken into consideration.

Energy conservation is a major item, which is linked with equipment specifications and applicable processes. Whereas environmental auditing in industries and the application of clean technologies can allocate points of energy wasting, continuously operated treatment plants show little potential for energy conservation. Adaptation of aeration rates to low wastewater flows (i.e. overnight) can contribute to the reduction of energy consumption.

Options for biogas recovery from landfill sites have to be evaluated and, if techno-economically feasible, practically implemented.

3. Organization

Introduction

The reliable performance of waste management systems depends not only on routine operation of plants but also on the overall organizational framework, within which they are established. The administrative, legislative and financial arrangements needed for the realization of projects have to be planned and formulated in time, in order to avoid delays and bottlenecks during the implementation phase (construction - operation).

The point presented in this chapter provide the guidance for the formulation of the organizational framework required here. It is obvious that this part of the pre-investment study cannot be elaborated without taking into account the existing legislation and administrative structure of the countries involved. Therefore the active involvement of the competent national / regional authorities and institutions is recommended.

3.1. Institutions

For an integrated management of facilities, a chain of institutional units has to be organized :

a) operating unit of facilities (wastewater treatment plants, landfill sites etc.)

b) coastal water control authority for the hot spot area

c) regional / national authority responsible for policy formulation - implementation

These institutions have to be incorporated into the existing administration scheme, where they have to be either newly established or existing units reorganized.

These new institutional arrangements have eventually to be supported with legislative amendments and with hiring of new personnel.

The most efficient way is to create independent organizational bodies, especially those responsible for the operation of facilities and for the coastal water control, in order to avoid overlapping with parallel activities within the existing administration.

In order to evaluate the capacities of the existing administrative and institutional framework and recommend eventual appropriate changes, the following activities have to be undertaken :

a) inventory of the existing institutional structure
   - **operating units for existing facilities** (treatment plants etc.)
   - **pollution control authorities / inspectorates**
   - **planning institutions at central** (i.e. ministries) **and regional level**

b) review of legislative and organizational framework

- C **basic environmental laws - regulations in force**
- C **commitments to international conventions**
- C **applicable effluent / ambient quality standards**
- C **characteristics of environmental policy** (time-table for policy implementation, focus on specific items like prevention of pollution, polluter-pays-principle etc., allocation of funds, strategic goals-targets for the improvement of environmental conditions etc.)
- C **environmental management procedures** (responsibilities of public/private actors, mechanisms for the enforcement of regulations, applied auditing / reporting methods for the assessment of the achieved environmental performance, planning of remedial actions etc.)

c) assessment of the capabilities and limitations of the existing system (legislation, organization, administrative / institutional structure)

- C **compliance of achieved results to set policy targets**
- C **description of the reasons of eventual drawbacks** (i.e. lack of trained personnel, inadequate allocation of funds, insufficient administrative / scientific support etc.)

d) specifications required for a new legislative, administrative / institutional system

- C **recommendations for the improvement of the existing system** (re-shuffling of responsibilities, hiring / training of personnel, new management procedures etc.)
- C **proposals for eventual expansion of institutions to cope with the management of the new facilities** (operating units, control authorities, regional / national authorities)
- C **detailed description of the features of new administrative units in case they should be installed** (responsibilities, legislative cover, budget required, hiring / training of personnel etc.)

3.2. Tasks

The operating unit will be responsible for the operation of facilities (routine operation, maintenance etc.). The coastal water control authority should undertake the inspection of facilities, monitoring of coastal water quality and reporting to national authorities.

The following tasks should form the core of the activities of this authority:

- C **collection of information** (condition of coastal and inland water in the hot spot area, assessment of loads from pollution sources, treatment facilities)
- C **monitoring of coastal waters and effluents** (development of a monitoring plan, periodical sampling - analysis of coastal waters-effluents)
- C **inspection-control of facilities**
- C **reporting**

The authorities responsible for policy formulation-implementation should :

- C **formulate the pollution control policy**
- C **prepare policy implementation** (legal cover, provision of resources, advertisement campaigns etc.)

C **adapt-modify this policy according to report findings**

4. Cost analysis - financing of projects

Introduction

Analysis and estimation of cost factors relevant to the execution of pollution control plans have become an important consideration in the development and evaluation of environmental policies. It is a complex task, where different methods and locally dependent assumptions can lead to strong variations of costs even for similar facilities. The situation becomes worse, when cost-benefit analysis of all cost indices should show in monetary terms the effectiveness of environmental investments beyond the direct financial expenditures (i.e. assessment of economic value of environmental quality-public health risks). This analysis has to be prepared by qualified experts (i.e. environmental economists) as part of the investment study.

This chapter provides “checklists” of key factors to be considered for cost estimations, thus enabling the methodological approach for the development of cost indices by relevant experts. In this context it must be emphasised that any simple “correct” method for cost estimations does not exist, nor would standardization of methods and assumption be reliable.

This chapter is structured in 3 parts :

C **capital - O/M costs of facilities**,

C **cost-benefit analysis**,

C **financing**

4.1. Capital - O/M costs

There are various methods for the estimation of capital (investment) and O/M costs of waste management facilities, such as unit price, curve pricing, comparable analysis etc., whereas cost-effectiveness analysis guidelines (U.S.E.P.A.) have also been developed.

Especially for municipal wastewater treatment plants, national figures expressed in investment costs per capita have been produced, allowing rough cost comparisons for similar facilities.

A classification of costs can be as follows :

capital costs

C **construction**

C **engineering**

C **land occupation**

C **legal, fiscal, administrative**

C **interest rate during construction phase**

O/M costs

C **personnel**

C **energy**

C **chemicals**

C **water**

C **miscellaneous utilities**

C **miscellaneous supplies - materials**

In Annex VI lists of detailed information on these costs are presented.

4.2. Cost-benefit analysis

In order to define the net value of an environmental investment, a sum of cost factors has to be calculated and subtracted from the expected benefits. The identification, quantification and valuation of all parameters involved should be based on a careful, step-by-step methodological approach assuring continuous checking of all relevant factors.

The following main elements should be identified and evaluated :

a) assessment of the project area
- C **coastal line and hinterland**
- C **natural environment** (resources, flora-fauna etc.)
- C **demographic-development trends** (population, socioeconomic activities, infrastructure)

b) environmental quality
- C **pollution sources/loads**
- C **environmental-health impacts**
- C **existing-planned pollution control facilities and measures**

c) cost analysis
- C **loss-depreciation of natural resources**
- C **negative impacts on health**
- C **investments for pollution control with associated O/M costs**
- C **monitoring of pollution** (legal, administrative, institutional, economic, technical and fiscal measures)

d) identification-quantification of benefits
- C **improvement of agricultural production, touristic and recreational activities**
- C **positive impacts on health** (i.e. reduced mortality) **and on the environment** (conservation of resources, nature protection)
- C **increase of land values**

The valuation of cost-benefits requires a differentiation of approach according to their variable nature, i.e. market prices can satisfactory describe the increased food production due to irrigation, whereas health benefits can be valued in reduced loss of earnings.

It is obvious that this complex cost-benefit analysis goes far beyond the estimation of direct costs for project realization (Chapter 4.1.). Therefore it has to be executed within the broader context of an integrated plan for the whole spot area as part of a regional development programme.

4.3. Financing

4.3.1. Investment costs

Funds for investment can be allocated by international financial institutions (i.e. World Bank, European Investment Bank), national banks etc. Projects applicable within European Union (E.U.) can benefit from the funding possibilities of various E.U. programmes (i.e structural funds), whereas financial support can be granted to E.U. associated countries for eligible projects within specific programmes (i.e. LIFE).

Bank loans in the usual method for cash flow, whereas subsidies for innovative investments in the environmental sector are sometimes provided in some countries (i.e. investments for new clean technologies in industry).

Before submitting an application for financial support, the following aspects should be considered :

- **detailed inventory of on-going financial programmes launched by national, international institutions, donors etc.**
- **assessment of the conditions required for submission of an application** (deadlines, time-table for project implementation, percentage of financial aid, pay-back period for loans etc.)
- **checking of project's eligibility with the prescribed conditions for financial support**
- **insurance of proposer's own financial contribution if required**
- **precise description of project's features and cost calculation according to the programme's requirements in question** (implementation phases, financial plan etc.)
- **consultation of proposer with local / regional / national authorities concerning the application and request for authorization / support** (letter of intent, bank guarantees etc.)

4.3.2. Revenue collection

Running costs of environmental facilities (O/M costs) should usually be covered by the user according to the polluter-pays-principle (PPP). This fact is rather obvious for industrial activities but it may cause difficulties to municipalities, where i.e. water supply charges have to be substantially increased to cover wastewater treatment costs. In this context the operational simplicity of facilities is a positive factor not only for technical and environmental reasons but also as economical parameter.

Applications of clean / recycling techniques in industry often allow O/M costs to be covered from revenues caused by water / energy conservation and by-products recovery. Therefore the preventive approach instead of "end-of-pipe" treatment is not only environmentally interesting but also economically attractive.

Imposing of environmental charges has to be carefully planned by considering certain conditions like :

- **the existing legislative / administrative framework in the region / country concerned**

- **each user's contribution to pollution load to be reduced** (i.e. connected industries / touristic units to municipal sewer network, population etc.)

- **development trends in the area** (forthcoming plans for new activities, population growth etc.)

- **charging requirements** (eventual pay-back of investment costs, O/M costs)

- **eventual subsidies to be granted by relevant authorities / institutions**

- **mechanisms for regular revenue collection**

- **public awareness, information of users.**

It must be emphasized that this last aspect (public awareness) should not be underestimated, since the acceptance of these charges by all actors concerned (population, industrial / touristic enterprises) is a basic prerequisite for the success of any system of revenue collection.

V. References

Metcalf-Eddy (1980), Wastewater engineering: treatment, disposal, reuse, McGraw-Hill

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Tsotsos, D. and A. Katsaounis (1990), Code of practice for environmentally sound management of liquid waste discharge in the Mediterranean Sea

UNEP/MAP-PAP/RAC, CAMP-Rhodes (1993), General Plan for Management of wastewater, Parts I & II

Tsotsos, D. (1977), Hot spots - sensitive areas country reports for Greece, Lebanon, Syria

ANNEX I

Reference: UNEP/MAP-WHO, hot spots ranking system (1st phase of the activity)

The prioritization of pollution hot spots will be done by evaluating the risk exerted by the point sources with effects on: public health, drinking water quality, recreation, other beneficial uses, aquatic life and economy and welfare.

A ranking system from 1-6 must be followed to show the severity of each of the effects on the identified hot spots. Therefore the pollution hot spots should be ranked by using the following criteria where (6) stands for extreme effects, (5) for severe effects, (4) for major effects, (3) for moderate effects, (2) for slight effects and (1) for no effects.

The following table explain the criteria for ranking the effects.

Public Health	
<u>extreme effects</u> (6)	Domestic wastewater loads of more than 30 tons BOD/day with no disinfection and having a high probability of direct contact to human beings. Wastewater containing more than 50 mg/L of heavy metals and having a possible contact to the public at the discharge point. Wastewater containing radioactivity or hazardous substances above WHO limitation.
<u>severe effects</u> (5)	Domestic wastewater loads of more than 15 tons BOD/day with no disinfection and having a high probability of direct contact to human beings. Wastewater containing more than 20 mg/L of heavy metals and having a possible contact to the public at the discharge point.
<u>major effects</u> (4)	Domestic wastewater loads of more than 10 tons BOD/day with no disinfection and having a high probability of direct contact to human beings. Wastewater containing more than 10 mg/L of heavy metals and having a possible contact to the public at the discharge point.
<u>moderate effects</u> (3)	Domestic wastewater or water containing heavy metals with no direct effect to human beings.
<u>slight effects</u> (2)	Any discharge which contains toxic substances or pathogens and is not mentioned in (3) - (6).
<u>no effects</u> (1)	Discharge with no effect.

Drinking Water Quality	
<u>extreme effects</u> (6)	Any wastewater directly discharged to a water body which is used as drinking water.
<u>severe effects</u> (5)	Any wastewater directly discharged to a water body which is not used as drinking water but is potentially a drinking water source.
<u>major effects</u> (4)	Indirect discharges to water bodies with improper filtration.
<u>moderate effects</u> (3)	Indirect discharges to a water body with proper infiltration.
<u>slight effects</u> (2)	Discharge representing a potential risk in emergency situations (flood, earthquake).
<u>no effects</u> (1)	Discharge with no effect.

ANNEX I

Recreation	
extreme effects (6)	Discharges with more than 300 mg/L of oil which may cause a significant odour that directly affects a recreational area from a distance of 100 m.
severe effects (5)	Discharges which may cause a significant odour that directly affects a recreational area from a distance of 500 m.
major effects (4)	Discharges with no odour at a distance of 1000 m from the recreational area deteriorating the aesthetic quality of waters.
moderate effects (3)	Discharges at a distance of 5000 m from the recreational area.
slight effects (2)	Discharges causing a potential risk to the environment.
no effects (1)	No effect.

Other Beneficial Uses	
extreme effects (6)	Discharges containing a high level of solid wastes or odours which can cease the present beneficial use of the water body (transportation, sport activities, aquaculture).
severe effects (5)	Discharges containing a high level of solid wastes or odours which can potentially cease the present beneficial use of the water body (transportation, sport activities, aquaculture).
major effects (4)	Discharges containing a high level of solid wastes or odours which can harm the present beneficial use of the water body (transportation, sport activities, aquaculture).
moderate effects (3)	Discharges containing a high level of solid wastes or odours which can potentially harm the present beneficial use of the water body (transportation, sport activities, aquaculture).
slight effects (2)	Discharges containing a high level of solid wastes or odours which may harm the present beneficial use of the water body (transportation, sport activities, aquaculture).
no effects (1)	Discharge with no effect.

Aquatic Life (including biodiversity)	
extreme effects (6)	Any discharge which may reduce the oxygen content of the receiving body below 0.5 mg O_2/L. Any discharge which contains a heavy metal concentration of more than 50 mg/L. Any discharge which contains an oil concentration of 400 mg/L.
severe effects (5)	Any discharge which may reduce the oxygen content of the receiving body below 1 mg O_2/L. Any discharge which contains a heavy metal concentration of more than 30 mg/L. Any discharge which contains an oil concentration of 200 mg/L.
major effects (4)	Any discharge which may reduce the oxygen content of the receiving body below 2 mg O_2/L. Any discharge which contains a heavy metal concentration of more than 20 mg/L. Any discharge which contains an oil concentration of 100 mg/L.
moderate effects (3)	Any discharge which causes oxygen depletion.
slight effects (2)	Any suspicious discharge.
no effects (1)	Discharge with no effect.

Economy and Welfare	
extreme effects (6)	Shutting down of discharging industries would have significant effect on the economy. Investment needed for environmental sound solution more than 20 million dollars.
severe effects (5)	Shutting down of discharging industries would have severe effect on the economy. Investment needed for environmental sound solution more than 10 million dollars.
major effects (4)	Shutting down of discharging industries would have major effect on the economy. Investment needed for environmental sound solution more than 5 million dollars.
moderate effects (3)	Discharging industries having little effect on the economy.
slight effects (2)	Discharging industries having no effect on the economy.
no effects (1)	Discharging industries having no effect on the economy, and already non-feasible for investment.

ANNEX II

Reference:

UNEP Regional Seas Reports and Studies No. 122, an approach to environmental impact assessment for projects affecting the coastal and marine environment (1990)

4.3 GENERAL GUIDELINES FOR PREPARATION OF AN ENVIRONMENTAL IMPACT ASSESSMENT DOCUMENT FOR A SEWAGE TREATMENT PLANT FOR A CITY WITH BETWEEN 100,000 AND 1.000.000 INHABITANTS

Basic considerations

Sewage treatment plants are constructed to transform the raw sewage into an easier manageable waste and to retrieve and reuse the treated sewage water.

The end products of a treatment plant are sludge and treated sewage water. Both products may contain, in addition to organic biodegradable substances and mircoorganisms, non-biodegradable and toxic substances due to the contamination of sewage with industrial waste waters.

From the environmental standpoint the most important aspect of a sewage treatment plant is the proposed disposal or use of the sludge and the treated sewage water.

The most common adverse environmental effects on coastal waters, connected with disposal or use of the sludge and the treated sewage water, are caused by: microbiological contamination, oxygen depletion due to high load of organic faecal matter, eutrophication caused by nutrients, and toxic and non-biodegradable substances originating mainly from contamination of sewage by industrial wastes.

Some treatment processes (e.g. oxydation ponds, aerated lagoons) may lead, under the influence of wind, to the spread of pathogens through air transport over considerable distances.

Most sewage treatment and disposal processes are a serious source of offensive odour.

Improperly constructed or operated sewage treatment plants and improper disposal or use of sludge and treated sewage water may become a most serious public health problem. Therefore, whatever level of treatment and method of disposal and use is approved, it should strictly comply with national standards and internationally accepted environmental quality criteria, taking into account the recipient environment and the biological targets which may be affected, specifically man.

Elements specifically recommended for inclusion in the follow-up monitoring and re-evaluation programme are: regular compliance with methods approved for sewage treatment and disposal, including for use of treated sewage water; seepage of contaminants from the treatment plants or sludge disposal sites into freshwater aquifers or coastal waters; wind transport of pathogens originating from the treatment plant or sludge disposal site; elements recommended for monitoring of submarine sewerage outfalls (see section 4.5) if such an outfall is part of the project.

Description of the proposed project

The proposed treatment plant should be described, accompanied by plans, preferably on a scale of 1:2500, including the following:

- Types of sewage to be treated (industrial, domestic, agricultural).
- Number of inhabitants to be served by the plant.
- Types of clients to be served, e.g. industrial, residential, commerical, hospitals.
- Quantity of sewage (cubic meters per day, per year).
- Quality of sewage to be treated, including suspended solids (mg/litre), settleable solids (mg/litre), pH, turbidity, conductivity, BOD (mg/litre), COD (mg/litre), nitrogen, ammonia, phosphate, oil, surfactants, and heavy metals such as arsenic, cadmium, copper, lead, nickel and mercury.
- Method to be used in treatment of sewage.
- Layout of the plant (including treatment facilities and service area).
- Use of effluents (agriculture, recharging aquifer, disposal to sea or to nearest river).
- Description of the plant's recipient body of water, if any.
- Sludge quantity and quality.
- Method of sludge treatment and disposal.
- Chemical, physical and bacteriological characteristics of effluents such as suspended solids, settleable solids, pH, turbidity, conductivity, BOD, COD, nitrogen, ammonia, phosphate, oil, surfactants, and heavy metals such as arsenic, cadmium, copper, lead, nickel and mercury, total coliforms, faecal coliforms and faecal streptococci.
- Programme for operation and maintenance of the sewage treatment plant.

Reasons for selecting the proposed site and the technologies

The reasons for selecting the proposed site and the technology proposed to be applied, including the short description of alternatives which have been considered, should be provided under this section.

Description of the environment

A description of the environment of the site without the proposed sewage treatment plant should concentrate on the immediate surroundings of the proposed project. The size of the area described will be determined by the predicted effects of the proposed plant.

(a) **Physical site characteristics**

- Site location on a map at a scale of 1:10,000 or 1:50,000 including residential areas, industrial areas and access roads.

(b) **Climatological and meteorological conditions**

- Basic meteorological data such as wind direction and wind velocity.

- Special climatic conditions such as storms, inversions, trapping and fumigation, proximity to seashore, average yearly rainfall and number of rainy days per year.

- Existing sources of air pollution, especially of particulates and odours.

(c) **Geological and hydrological conditions**

- Geological structure of proposed area, including hydrology and aquifers.

- Existing uses of water bodies around the proposed site and the quality of the water.

(d) **Present land use of the site and its surroundings**

(e) **Characteristics of sea area which will be recipient of discharged treated sewage**

- Sea circulation, existence and characteristics of the thermocline, thermohaline structure, dissolved oxygen and nutrients concentration, microbial pollution, fishing grounds, aquaculture sites, marine habitats.

(f) **Existence of endemic water borne diseases**

Identification of possible impacts

An assessment of anticipated or forecasted positive or negative impacts, using accepted standards whenever possible, of short term impacts associated with the activities related to the construction of the plant and long term impacts related to the functioning of the treatment plant should be given, including the following:

- Odours and air pollution from the plant and from the disposal of effluents and sludge.

- Inlitration of sewage into topsoil, aquifer or water supply and impact on drinking water quality.

- Mosquito breeding and diseases transmitted by mosquitoes.

- Pollution of water bodies such as rivers, lakes or sea by effluents and impact on bathing water quality.

- Flora and fauna.

- Fruit and vegetable safety, if land disposal of effluent or sludge.

- Noise levels around plant and its sources.

- Solid waste disposal of sludge and other wastes.

- Devaluation of property values.

- Tourist and recreation areas such as nature reserves, forests, parks, monuments, sport centers, beaches, and other open areas which would be impacts.

- Possible emergencies and plant failure, the frequency at which they may occur, and possible consequences of such emergencies.

- Anticipated or foreseeable impacts on the areas outside of national jurisdiction.

ANNEX II

Proposed measures to prevent, reduce or mitigate the negative effects of the proposed plant

This section should describe all measures - whether technical, legal, social, economic or other - to prevent, reduce or mitigate the negative effects of the proposed sewage treatment plant.

Proposed programme for monitoring of the environmental impact of the project

Measures to be used to monitor the effects on a long term basis, including the collection of data, the analysis of data, and the enforcement procedures which are available to ensure implementation of the measures.

ANNEX III

Reference:

UNEP/MAP-PAP/RAC, CAMP Rhodes: general plan for management of wastewater, part II (1993)

Water quality criteria for irrigation[1]

Potential Irrigation Problem	Units	Degree of Restriction on Use		
		None	Slight to Moderate	Severe
Salinity (affects crop water availability)[2]				
EC_w	dS/m	< 0.7	0.7 – 3.0	> 3.0
(or)				
TDS	mg/l	< 450	450 – 2000	> 2000
Infiltration (affects infiltration rate of water into the soil. Evaluation using EC_w and SAR together)[3]				
SAR = 0 – 3 and EC_w =		> 0.7	0.7 – 0.2	< 0.2
= 3 – 6 =		> 1.2	1.2 – 0.3	< 0.3
= 6 – 12 =		> 1.9	1.9 – 0.5	< 0.5
= 12 – 20 =		> 2.9	2.9 – 1.3	< 1.3
= 20 – 40 =		> 5.0	5.0 – 2.9	< 2.9
Specific Ion Toxicity (affects sensitive Crops)				
Sodium (Na)[4]				
surface irrigation	SAR	< 3	3 – 9	< 9
sprinkler irrigation	me/l	< 3	< 3	
Chloride (Cl)[4]				
surface irrigation	me/l	< 4	4 – 10	> 10
sprinkler irrigation	me/l	< 3	<3	
Boron (B)	mg/l	< 0.7	0.7 – 3.0	> 3.0
Trace Elements (see Table 3)				
Miscellaneous Effects (affects susceptible crops)				
Nitrogen (NO_3 – N)[5]	mg/l	<5	5 – 30	>30
Bicarbonate (HCO_3) (overhead sprinkling only)	me/l	<1.5	1.5 – 8.5	> 8.5
pH			Normal Range 6.5–8.4	

1 Adapted from FAO Irrigation and Drainage Paper No. 29 Rev. 1, 1985.

2 EC_w means electrical conductivity, a measure of the water salinity, reported in deciSiemens per metre at 25°C (dS/m) or in units millimhos per centimetre (mmho/cm). Both are equivalent. TDS means total dissolved solids, reported in milligrams per litre (mg/l).

3 SAR means sodium adsorption ration. SAR is sometimes reported by the symbol RNa. At a given SAR, infiltration rate increases as water salinity increases. Evaluate the potential infiltration problem by SAR as modified by EC_w.

4 For surface irrigation, most tree crops and woody plants are sensitive to sodium and chloride; use the values shown. Most annual crops are not sensitive. With overhead sprinkler irrigation and low humidity (< 30 per cent), sodium and chloride may be absorbed through the leaves of sensitive crops.

5 NO_3-N means nitrate nitrogen reported in terms of elemental nitrogen (NH_4 and Organic-N should be included when wastewater is being tested).

Recommended maximum concentrations of trace elements in irrigation waters

Metal	Recommended Maximum Concentration	Impact on Soils and Biota
Aluminium (Al)	5.0	Can cause non-productivity in acid soils(PH 5.5), but more alkaline soils at pH 7.0 will precipitate the ion and eliminate any toxicity.
Beryllium (Be)	0.10	Toxicity to plants varies widely, ranging from 5 mg/l for kale to 0.5 mg/l for bush beans.
Cadmium (Cd)	0.01	Toxic to beans, beets and turnips at concentrations as low as 0.1 mg/l in nutrient solutions. Conservative limits recommended due to its potential for accumulation in plants and soils to concentration that may be harmful to humans.
Cobalt (Co)	0.05	Toxic to tomato plants at 0.1 mg/l in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Chromium (Cr)	0.20	Not generally recognized as an essential growth element. Conservative limits recommended due to lack of knowledge on its toxicity to plants.
Copper (Cu)	0.20	Toxic to a number of plants at 0.1 to 1.0 mg/l in nutrient solutions.
Iron (Fe)	5.0	Not toxic to plants in aerated soils, but can contribute to soil acidification and loss of availability of essential phosphorus and molybdenum. Overhead sprinkling may result in unsightly deposits on plants, equipment and buildings.
Lithium (Li)	2.5	Tolerated by most crops up to 5 mg/l; mobile in soil. Toxic to citrus at low concentrations (0.075 mg/l). Acts similarly to boron.
Manganese (Mn)	0.20	Toxic to a number of crops at a few- tenths to a few mg/l, but usually only in acid soils.
Molybdenum (Mo)	0.01	Not toxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high concentrations of available molybdenum.
Nickel (Ni)	0.20	Toxic to a number of plants at 0.5 mg/l to 1.0 mg/l; reduced toxicity at neutral or alkaline pH.
Lead (Pb)	5.0	Can inhibit plant cell growth at very high concentrations.
Selenium (Se)	0.02	Toxic to plants at concentrations as low as 0.025 mg/l and toxic to livestock if forage is grown in soils with relatively high levels of added selenium. An essential element to animals but in very low concentrations.
Vanadium (V)	0.10	Toxic to many plants at relatively low concentrations.
Zinc (Zn)	2.0	Toxic to many plants at widely varying concentrations; reduced toxicity at pH 6.0 and in fine textured or organic soils.

Treatment requirements for effluents to be used for irrigation

Characteristics of the Wastewater	mg/l	Agriculture and health standard required	Appropriate Treatment methods.
Dissolved Solids	500	No restriction for irrigation in relation to salinity. 450 mg/l TDS refers to good quality water.	No treatment.
Suspended Solids	200	Can create problems in irrigation systems. Level should be reduced to 50 mg/l for use in drip and micro irrigation.	Primary and secondary treatment or waste stabilization ponds.
Nitrogen	40	Should be reduced to about 25 to 30 mg/l for most crops. For sensitive crops the recommended level is 5 mg/l.	During normal primary and secondary treatment or waste stabilization ponds the level on N is reduced to 10-20 mg/l. Vegetative beds or activated sludge methods can be used if nitrate is to be reduced to very low levels.
Phosphorus	10	No agriculture related problem is expected at this level.	No treatment.
Chloride	50	No chloride toxicity is expected at this level	No treatment.
Alkalinity	100	No major problem is expected in normal irrigation systems. In drip irrigation systems the drippers may get clogged. This problem can be solved by acid treatment.	No treatment.
Grease	100	This should be removed, as it can cause problems in irrigation pipes, oil deposited on soil and reduce quality of crops when sprinkler method of irrigation is used.	Removed by primary treatment processes or in waste stabilization ponds.
BOD	200	This must be reduced to 50 mg/l for restricted irrigation and 15 to 20 mg/l for unrestricted irrigation.	Primary and secondary treatment with chlorination or waste stabilization on ponds with retention time of 20 to 40 days.

ANNEX IV

Reference:

PAP/RAC, code of practice for environmentally sound management of liquid waste discharge in the Mediterranean Sea (1990)

ANNEX IV

Table 1: Operational characteristics of various treatment processes (76)

Item	Rotating disk	Trickling filters	Activated sludge (1)	Activated sludge (2)	Facultative lagoons
Process characteristics					
Reliability with respect to:					
Basic process	Good	Good	Fair	Very good	Good
Influent flow variations	Fair	Fair	Fair	Good	Good
Influent load variations	Fair	Fair	Fair	Good	Good
Presence of industrial waste	Good	Good	Good	Good	Good
Industrial shock loadings	Fair	Fair	Fair	Good	Fair
Low temperature < 20°C	Sensitive	Sensitive	Good	Good	Very sensitive
Expandability to meet:					
Increased plant loadings	Good, must add disk modules	Good	Fair to good if designed conservatively	Good, ultimately more volume will be required	Fair, additional ponds required
More stringent discharge requirements with respect to:					
SS	Good, add filtration or polishing lagoons.	Good, add filtration or polishing lagoons	Good, add filtration or polishing lagoons	Good, add filtration or polishing lagoons	Add additional lagoons and filtration
BOD	Improved by filtration	Improved by filtration	Improved by filtration	Improved by filtration	Improved by filtration

(Table 1 continued)

Item	Rotating disk	Trickling filters	Activated sludge (1)	Activated sludge (2)	Facultative lagoons
Nitrogen	Good, denitrification must be added	Good, denitrification must be added	Good, denitrification must be added	Good, denitrification must be added	Fair
Operational complexity	Some, to simple	Some, to simple	Moderately complex	Some	Simple
Ease of operation and maintenance	Very good	Very good	Fair	Very good	Very good
Power requirements	Low	Relatively high	High	Relatively high	Low
Waste products	Sludges	Sludges	Sludges	Sludges	Sludges
Potential environmental impacts	Odours	Odours	-	-	Odours
Site Considerations					
Land area requirements	Moderate plus buffer zone	Moderate plus buffer zone	Moderate plus buffer zone	Large plus buffer zone	Large plus buffer zone
Topography	Relatively level	Relatively level	Relatively level	Relatively level	Relatively level

(1) Complete mix and contact stabilization
(2) Extended aeration and oxidation ditch

Additional information could be found in References (95) and (98).

ANNEX IV

Tab[illegible] 2: Operational characteristics of activated proces[illegible](23)

Process modification	Flow model	Aeration system	BOD removal efficiency, %	Remarks
Conventional	Plug flow	Diffused air, mechanical aerators	85-95	Use for low-strength domestic wastes. Process is susceptible to shock loads.
Tapered aeration	Plug flow	Diffused air	85-95	Air supply tapered to match organic loading demand.
Continuous-flow stirred-tank reactor	Continuous-flow stirred-tank reactor	Diffused air, mechanical aerators	85-95	Use for general application. Process is resistant to shock loads.
Step aeration	Plug flow	Diffused air	85-95	Use for general application to wide range of waste.
Modified aeration	Plug flow	Diffused air	60-75	Use for intermediate degree of treatment where celltissue in the effluent is not objectionable.
Contact stabilization	Plug flow	Diffused air, mechanical aerators	80-90	Use for expansion of existing systems, package plants. Process is flexible.
Extended aeration	Continuous-flow stirred-tank reactor	Diffused air	75-95	Use for small communities, package plants. Process is flexible.
Kraus process	Plug flow	Diffused air	85-95	Use for low-nitrogen, high-strength wastes.
High-rate aeration	Continuous-flow stirred-tank reactor	Mechanical aerators	75-90	Use for general applications with turbine aerators to transfer oxygen and control the floc size.
Pure-oxygen systems	Continuous-flow stirred-tank reactors in series	Pure oxygen with mechanical dispersion	85-95	Use for general application where limited volume is available, near economical source of oxygen (turbine or surface aerators).

Additional information could be found in Reference (99).

ANNEX V

Reference:

PAP/RAC, code of practice for environmentally sound management of liquid waste discharge in the Mediterranean Sea (1990)

FORMAT AND CONTENTS OF A PRELIMINARY DESIGN REPORT (79)

Report Cover

Preliminary Design Report, Sewage Works Proposal

Letter of Transmittal

A one page letter bound into the report and including:

- Submission of report to the approval agency,
- Statement of feasibility of recommended project,
- Acknowledgement to giving assistence.

Title Page

Title of priority
Municipality, country, concession and lot numbers (as applicable)
Name, address and telephone number of individual (firm) preparing the report

Table of Contents

Section headings, chapter headings and subheadings
Maps
Figures
Appendices
Number all pages and cross-reference by page number

Summary

Highlights, very briefly, what was found from the investigation:
Findings
Population - present, design (when), ultimate
Land use and zoning-portions: residential, commercial, industrial, green belt, etc.
Wastewater characteristics and concentrations - portions of total hydraulic, organic, and solids loading attributed to residential, commercial and industrial fractions.
Collection systems projects - immediate needs to implement recommended projects, deferred needs to complete recommended projects, and pump stations, force mains, appurtenances, etc.
Selected treatment process - characteristics of process and of output.
Receiving waters - existing water quality and quantity, classifications and downstream water uses and impact of project on the receiving water.
Proposed project - total project cost, total annual expense requirement for: debt service, operation and personnel.

Introduction

ANNEX V

Background

Reasons for the report (approval process)

Scope

Guidelines for developing the report, including preliminary design of selected system and costing.

Purpose

Presentation of appropriate past history.

General

Existing development, expansion, annexation, intermunicipal service, ultimate development.
Drainage basin, portion covered.
Population growth, trends, increase during design life of the facility.
Residential, commercial and industrial land use, zoning, population densities, industrial types and concentrations (if applicable).
Topography, general geology, and effect on project.
Meteorology, precipitations, runoff, flooding, etc., and effect on project.
Identification of environmentally sensitive conditions within the planning boundary, including areas of natural beauty, wildlife, recreational areas and historic sites.

Regulations, Guidelines and Ordinances

Presentation of applicable regulations, guidelines and ordinances.
Sewer-use ordinance (if applicable).
Existing contracts and agreements.
Surcharge rates and basis for surcharge (in effect).
Enforcement provisions including inspection sampling, detection, penalties. etc.

Existing Facilities Evaluation

Existing Collection System

Inventory of existing sewers.
Isolation from water-supply wells (if applicable).
Structural condition, hydraulic capacity of existing system.
Identification of collection system problems - overflows, infiltration, exfiltration - by gauging and/or studying water supply relationships.
Outline repair, replacement and storm water separation requirements and/or possibilities.

Establish renovation priorities.
Present recommended programme to renovate sewers.
Estimate required expenditure to renovate sewers and prepare implementation outline.

Existing Wastewater Treatment Site

Area for expansion.
Terrain.
Subsurface conditions.
Isolation from habitation.
Isolation from water-supply structures.
General aesthetic appearance, odour problems.
Flooding.

Existing Process Facilities

Capacities and adequacy of various treatment components.
Relationship and/or applicability to proposed project.
Age and condition.
Adaptability to different usages.
Structures which could/should be retained, modified or demolished.

Existing Wastewater Characteristics

Water consumption (from available records).
Wastewater flow pattern, peaks, total, design flow.
Physical, chemical and biological characteristics and concentrations.

Existing Receiving Body of Water

Receiving water base flow (as specified by regulatory agency).
Characteristics of receiving water (as specified by regulatory agency).
Downstream water uses.
Impact of proposed discharge on receiving water effluents objectives.
Flagging of environmentally sensitive conditions (e.g., shellfish beds, spawning grounds, beaches).

Evaluation of Project Alternative

Regionalization

Consideration should be given to regional sewage facility planning whenever feasible. Municipalities (or private installations, institutions, etc.) may join together in cooperative regional treatment system provided costs, as related to collection, treatment and disposal, as well as operation and maintenance commitments, are jointly shared and deemed favourable by the parties involved. Detailed investigation of regional schemes should be undertaken if cursory review indicates project feasibility. Comparison of regional versus non-regional solutions should be made and the optimum scheme selected on the basis of this comparison.

Community Systems

Site Requirements

Comparison of advantages and disadvantages of locating proposed treatment works at either existing treatment site or new site(s) based on the following criteria:

- land availability (zoning, local ordinances, etc.) and soils;
- expansion possibilities;
- hydraulic requirements;
- energy requirements;
- flood control;
- accessibility;
- aesthetic (odour problems, landscaping, etc.);
- protection afforded to public health and the receiving environment (environmental sensitivity, etc. of the receiving environment);
- public opinion;
- costs (land, services).

Selection of Preferred Site

Justification of selection based upon economic feasibility, environmental compatibility, compliance with applicable ordinances, regulations and guidelines.

Collection System Alternatives

Inventory of proposed additions.
Consideration of area of service.
Unusual construction problems.

Alternative Collection Systems Costs

Flow/waste reduction considerations.

Selection of preferred collection method and/or combination of sellection methods.

Justification of selection based upon economic feasibility, environmental compatibility, compliance with applicable ordinances, regulations, guidelines.

Treatment Process Alternatives

Tabulation of required plant performance based upon receiving water quality criteria and effluent criteria.

Description and delineation (line diagram) of applicable treatment alternatives.

Discussion on advantages and disadvantages of each (e.g., reliability, flexibility, complexity of operation, resource requirements, operation and maintenance requirements, aesthetics, adaptability to future needs, availability of power).

Characteristics of process output (e.g., continuous or seasonal effluent discharge, volume and stability of waste solids).

Comparison of process performances.

Estimates of alternate process costs including capital, construction, installation, and operation and maintenance estimates (all costs on an annual basis, i.e. amortized capital and O and M).

Selection of preferred process.

Justification of selection based upon economic feasibility, environmental compatibility, water quality objectives, compliance.

Ordinances, regulations and guidelines.

Preliminary Design of Process Facilities

Discussion of design criteria (average daily flow, flow variations, waste characteristics, effluent quality, treatment efficiency, design life).

Sizing of collection system and treatment process components on the basis of above discussion and design parameters.

Liquid effluent disposal requirements.

Waste solids processing and disposal requirements, support equipment and facilities (flow measurement device, sampling equipment, process control, work and laboratory area, and laboratory equipment, safety equipment).

Cost Summary and Implementation Schedule

Tabulation of capital expenditure and annual operation and maintenance requirements (capital expenditure broken down into unit cost for various components of collection, treatment and disposal system, and amortized over the design life of the system (20 years).

Implementation schedule, including immediate and deferred construction (and effect on costs), interruption of existing utilities and traffic interference, restoration of pavements, lawns, etc., operation of existing treatment and disposal facilities during construction period, scheduling of design and construction phases.

Appendices: Technical Information and Design Criteria
Raw Wastewater Characterization Programme

Description of the programme including location of monitoring stations, duration of study, type of sampling equipment utilized, frequency of sample collection, sample storage, method of sample analyses, and analyses performed.

Tabulation of data.

Data analysis including diurnal flow variations, organic loadings, nutrient concentrations.

Collection System Design

Design tabulations - flow, size, velocities, etc.
Pump station calculations
Special appurtenances
Construction problems
System map (report size)
Process facilities design
Criteria selection and basis
Hydraulic and organic loadings - minimum, average, maximum and effects.
Unit dimensions
Rates and velocities
Detention
Concentrations
Recycle
Chemical additive control
Physical control
Removals: effluent concentrations, etc. Include a separate tabulation for each unit to handle solid and liquid fractions.

Process Diagrams

Process configuration, interconnecting piping, flexibility, etc.
Hydraulic profile
Solids control system
Flow diagram with capacities, etc.
Operation and maintenance
Routine and special maintenance duties
Process control and laboratory analysis
Time requirements
Tools, equipment, safety, etc.
Personnel requirements - number, type, qualifications, salaries, benefits (tabulate)

Chemical Control

Processes needing chemical addition
Chemical and feed equipment
Tabulation of ammounts and unit and total cost

Support Data

Outline unusual specifications, construction materials and construction methods.
Maps, photographs, diagrams (report size)
Other

ANNEX VI

Reference:

PAP/RAC, code of practice for environmentally sound management of liquid waste discharge in the Mediterranean Sea (1990)

Table 1. Capital cost items (27, 29, 31)

The following is one way to categorise the various costs of a pollution abatement system. Often, many of these items will be aggregated into other categories. Because different cost estimators may use different classifications, each "specific description" should itemise clearly what is included in each category. The "Source and Method" should note the derivation of the estimate, such as "equals 10 % of Item 1a".

Pollution Control System of Component: ____________ Construction Time: (months or years) ____________ Start-up Date: ____________

Item	Definition	Specific Description	Value	Source and Method of Estimate
1. Equipment and Supplies				
a. Main process, equipment and machinery	Delivered cost of all major items of purchased equipment for the process or pollution abatement system under study (including applicable sales, tax and freight charges).			
b. Ancillary materials and supplies	Includes the cost of all instrumentation, piping, insulation, ductwork, structural and electrical materials needed to install the system.			
2. Field labour and supervision	Salaries and wages of all field personnel needed to install the complete system			
3. Buildings and site development	Includes the cost of excavation, foundations, building and storage facilities.			

Table 1. (continued)

Item		Definition	Specific Description	Value	Source and Method of Estimate
4.	General facilities	Service facilities include maintenance shops, roads and railroad facilities etc., utilities include investments for electrical substations, conduit, steam, process water, fire and service water, instrument air, chilled water, inert gas, and compressed air distribution facilities; miscellaneaous includes landscaping, etc.			
5.	Construction expenses (temporary installations) and Special Compensation	Includes costs for mobile equipment, temporary lighting, construction roads, raw water supply, safety and sanitary facilities, and other similar expenses incurred during construction. Also includes compensation for property loss and survey expenses.			
6.	Engineering design and contractor fees	Includes all costs for detailed engineering design and specifications of the project, plus all fees paid to an architect--engineering firm or other contractor.			
7.	Contingencies	Compensation for unforeseen expenses that may occur; magnitude may depend on the type and stage of development of the abatement process and on the level of detail of the cost estimate.			
8.	TOTAL PLANT COST	Sum of items 1-7. Total fixed investment (excluding land) required to purchase and install the complete system.			

Table 2. Annual operating cost items (27, 29, 31)

The following is one way to categorise the various costs of a pollution abatement system. Often, many these items will be aggregated into other categories. Because different cost estimators may use differe classification each "specific description" should itemise clearly what is included in each category. The "Sou and Method" should note the derivation of the estimate, such as "equals 10 % of Item 1a".

Pollution Control System of Component: __________ Construction Time: (months or years) __________ Start-up date: __________

Item	Definition	Specific Description	Unit cost	Total cost	Source and Meth of Estimate
Fixed O & M					
1. Operating labour and supervision	Total personnel costs required for plant or system operation.				
2. Maintenance	Includes all labour and materials associated with normal system maintenance and repair.				
3. Plant and Administration Overhead	Includes general plant services, general engineering (excluding maintenance) interplant communications and transportation; and expences connected with management activities, including the marketing process by products.				
Subtotal:					
Variable O & M					
4. Raw materials	Consumables required for their chemical or physical properties, other than fuel for the production of heat.				

Table 1. (continued)

Item	Definition	Specific Description	Value	Source and Method of Estimate
9. LAND COST	Total cost of all land associated with the project.			
10. WORKING CAPITAL	The total ammount of money invested in raw materials, supplies, finished products, accounts receivable, and money on deposit for payment of operating expenses. Sometimes is included as part of first year operating expenses.			
11. STARTUP AND MODIFICATION COSTS	Cost covering operator training, equipment checkout, major changes in plant equipment, extra maintenance, and inefficient use of fuel and other materials during plant startup.			
12. INTEREST DURING CONSTRUCTION	Cost of money expended over the project construction period.			
13. TOTAL CAPITAL COST	Sum of items 8-12.			

Table 2. (continued)

Item	Definition	Specific Description	Unit cost	Total cost	Source and Metl of Estimate
5. Utilities	Energy and related purchased services, such as steam, electricity, process water, fuel oil, and heat credits.				
6. Miscellaneous	Includes costs of chemical and other laboratory analyses performance tests, monitoring and other miscellaneous costs.				
Subtotal:					
7. By-Product Sales	Income from sale of process by-products.				
8. Cost of Capital	Annual cost of interest on debt plus return on common and preferred equity.				
9. Taxes and insurance	Includes all applicable income taxes, tax credits, depreciation allowances, property taxes, and valorum taxes and insurance.				
10. Interim replacements	Cost of replacing major system components prior to assumed lifetime.				
11. TOTAL ANNUAL REVENUE REQUIREMENTS	Sum of items 1-10.				

ANNEX VI

Table 3. Classification of uncertainty in capital cost estimates (27, 29, 31)

Grade	Purpose	Minimum information required	Predict accurac +%	-
Order of magnitude (ratio estimate)	Preliminary feasibility study to determine whether continued investigation is merited. Rough comparison of alternatives.	General design basis, (a) flowsheet material balance, heat and energy balance. For the order of magnitude estimates this information is of a tentative nature, developed from a preliminary process concept.	50	5
Study (factored estimate)	Comparison of alternative. Preliminary screening. Preliminary budget preparation. Authorization for funding for an engineering study or for development of additional information.	All of the above on a firm rather than tentative basis plus overall layout of manufacturing facilities, sized equipment and instrument lists, and performance data sheets.	40	2
Preliminary (initial budget or scope estimate)	Preliminary budget approval. More accurate comparison of alternatives. Follow up of an order of magintude or study estimate.	All of the study estimate requirements plus process control diagrams, process piping sketches with sizes, plan and elevation drawings, offsite descriptions including sizes and capacities.	30	1
Definite (project control estimate)	Final capital authorisation. Project cost control. Follow up on order of magnitude, study or preliminary estimates for more information. Generally reserved for a real construction project with a known site.	All of the preliminary estimate requirements plus piping plan and elevation drawings integrated with the equipment plan and elevation drawings, electrical accurate layout single line drawings, detailed piping and instrumentation flowsheets, layout of non manufacturing facilities, design sketches for unusual equipment items, and specific site data including utilities and transportation availability, soil bearing, wind and snow loads.	20	1

(a) General design basis includes product, product specifications, plant capacity, storage requiremen operating steam time, provisions for expansion, raw materials and their storage requirements.