24 June 1988

Our letter of 7/8/88

UNITED NATIONS DEVELOPMENT PROGRAMME
PROJECT OF THE GOVERNMENTS OF
BRUNEI DARUSSALAM, INDONESIA, MALAYSIA,
PHILIPPINES, SINGAPORE AND THAILAND

PROJECT DOCUMENT

| | | |
|---|---|---|
| TITLE | : | ANTI-POLLUTION TECHNOLOGIES FOR URBAN AND RURAL AREAS IN THE ASEAN REGION |
| NUMBER | : | RAS/86/111/D/01/31 |
| DURATION | : | TWO YEARS (1988-1989) |
| PRIMARY FUNCTIONS | : | (I) EXPERIMENTAL CUM PILOT PROJECTS<br>(II) DIRECT TRAINING |
| SECONDARY FUNCTIONS | : | INSTITUTION-BUILDING |
| SECTOR (GOVT. CLASS) | : | INDUSTRY (UNDP CLASS & CODE) INDUSTRY (05) |
| SUB-SECTOR (GOVT. CLASS) | : | |
| GOVERNMENT IMPLEMENTING AGENCY | : | RELEVANT GOVERNMENT AGENCIES/INSTITUTIONS OF ASEAN COUNTRIES |
| EXECUTING AGENCY | : | UNDP/OPE |
| ESTIMATED STARTING DATE | : | FEBRUARY 1988 |
| GOVERNMENT INPUTS | : | IN KIND |

The project is amended to reflect conversion from the preparatory assistance phase to full approval.

| | |
|---|---|
| Previous UNDP input (Code C) | $ 20 000 |
| Revised UNDP input (Code D) | $441 500 |
| Increase | $421 500 |

SIGNED: via UNDP Jakarta's telex DP390
on behalf of the ASEAN GOVERNMENTS

DATE: 20 May 1988

on behalf of the EXECUTING AGENCY

DATE: 6.6.1988

on behalf of the UNITED NATIONS
DEVELOPMENT PROGRAMME

DATE: 14/6/88

**Sebastian K. Zacharia, Chief**
**Division for the Regional Programme**
**Regional Bureau for Asia and the Pacific**

## PART I - LEGAL CONTEXT

This project document shall be the instrument referred to as such in Article 1, paragraph 1 of the Basic Assistance Agreement between the United Nations Development Programme (UNDP) and the governments of those participating countries which have signed such an Agreement. Alternatively, for those participating countries which have not signed such an Agreement, this project document shall be the instrument referred to as a plan of operation envisaged in Article 1, paragraph 2 of the Agreement concerning assistance under the Special Fund Sector of UNDP between UNDP and the governments of those participating countries which have signed such latter agreement.

## PART II THE PROJECT

This document describes the efforts and technical co-operation among ASEAN countries in the development of anti-pollution technologies essentially for overcoming the environmental problems caused by certain indigenous industries that have been identified as having significant impact on the environment of the ASEAN countries and requiring priority attention. The framework and activities of the project were discussed and accepted by the ASEAN countries during the Consultant's missions to the ASEAN countries undertaken from 24-29 May 1987 and 9-30 June 1987. The member countries are in agreement that the activities carried out under the project will not only strengthen national capabilities but also lead to the achievement of self-reliance in the protection and enhancement of the quality of the environment in the ASEAN region.

### A. Development Objectives

The development objective of this project is to contribute to effective environmental management in accordance with the national environmental policies of the ASEAN member countries and in so doing help protect and maintain a satisfactory environmental quality in the region while forging ahead with the most needed economic development. This is envisaged through:

1) the development of indigenous technologies for the handling, treatment and disposal of wastes which are economically viable and appropriate to the local situation;

2) adaptation of technology from advanced/developed countries wherever applicable, particularly in the field of air and noise pollution control and measurement, with suitable modification to make them more economically viable in the local context;

3) innovation and modification of air quality monitoring techniques and equipment suitable to the local situation;

4) achieving self-reliance in environmental management through enhancement of institutional capability for co-operative exchange of research results and technical know-how as well as training of manpower on a regional basis.

B. Immediate Objective

1) Avoiding duplication of efforts and wastage of funds through sharing of research and development efforts among ASEAN institutions for alleviating common environmental problems in the region.

2) To offset or minimise the financial burden of anti-pollution measures through resource conservation entailing waste utilisation, effluent reuse, by-product production and development of low-waste and non-waste technology as has been successfully done in the case of palm oil and rubber industries in Malaysia.

3) Enhance and re-inforce national capabilities in the ASEAN region in the enforcement of legislations pertaining to control of pollution in general and in indigenous industries with significant environmental impact, in particular.

4) Upgrade capabilities within the region for the fabrication and maintenance of air quality monitoring equipment including the development of the framework for a regional training centre for air quality monitoring as well as the development of air quality monitoring techniques suitable to the local situation.

5) Upgrade capabilities within the region in the field of noise pollution measurement and control.

6) Production of manuals on anti-pollution technologies, air quality monitoring techniques and equipment maintenance and organisation of training workshops as a means of information exchange and dissemination and on the use of the manuals.

The immediate objectives of this project are further elaborated in the matrix (Annex 1).

C. Special Considerations

ASEAN (The Association of South-East Asian Nations) since its inception in 1967 has advocated technical collaboration among member countries which has been progressively promoted throughout the years resulting in a continuing exchange of information and expertise

for the benefit of the member countries. In the spirit of ASEAN, member countries of the region share the feeling that there are common and similar environmental issues which could be alleviated through active technical co-operation and collaboration among themselves, availing themselves at the same time of the technical collaboration of international and bilateral agencies.

In this decade of the eighties, the six ASEAN countries, Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand have the potential of becoming one of the fastest growing regions of the world. The region itself is richly endowed with natural resources; the ASEAN countries are determined to pursue a development pattern which results in significant and sustained improvement in the standard of living of their people. In order to ensure sustained development, countries of the region have taken cognizance of environmental issues. For this purpose governmental mechanisms have been established at the Ministerial level in all ASEAN countries to coordinate and supervise environmental activities.

As early as 1977, the United Nations Environment Programme (UNEP) provided the impetus for the establishment of an ASEAN Sub-regional Environment Programme (ASEP) as the collective answer to the environmental concerns of the ASEAN member countries. UNEP also helped to formulate the sub-regional environment programme, and to identify collaborative activities among the member countries concerned. An

Experts Group on Environment, consisting of representatives from the ASEAN countries has been established under the ASEAN Committee on Science and Technology as a forum for dealing with the environmental aspects of this region.

Since its first meeting in 1978, the ASEAN Experts Group on the Environment has met 10 times to ensure that collaborative activities answer the needs of ASEAN individual member countries. The past ten years have reconfirmed the exemplary spirit of co-operation among ASEAN countries on environment. During this period action plans have been formulated for several priority areas. The first phase of this co-operative environment programme has been successfully implemented which set the stage for a more intensified sub-regional co-operation in the environmental field. The ASEAN is now in the process of implementing its second phase of the Environment Programme, ASEP II, which is designed to be action-oriented with emphasis on solving immediate needs of the region. The ultimate objective of ASEP II is to strengthen regional collaboration in environmental management aimed at regional self-reliance. This project - "Anti-Pollution Technologies for Urban and Rural Areas in the ASEAN Region" - forms one of the projects under ASEP II which has been accorded high priority by the ASEAN member countries. This project should be accorded special consideration as it concerns a large segment of the population, i.e. the rural communities which are often left out of the development process. This project also helps to ensure the preservation and enhancement of environmental conditions in rural areas. It is also in accordance with the goal of conservation of resources.

## D. Background and Justification

For many years, the major environmental problems in the ASEAN region stemmed from the relative lack of development and inadequate infra-structural facilities, in short, poverty itself seemed polluting. Therefore, countries of the region have generally considered economic growth and industrialisation as key development priorities and concern for protection of the environment has been regarded as of secondary importance. Hence, the situation in many of the countries of the region, until recently was that concern over environmental quality becomes minted in the process of marshalling resources to meet priority development goals. Higher agricultural productivity, maximising incomes and boosting living standards, balanced development between regions and improved health care are but a few of these goals. Development thus proceeded apace with industrialisation being the favoured path for accelerated socio-economic development through increases in output, income and job opportunities. This very process of rapid development brought to the fore problems of a second order, namely, damage and disruption to the human environment which not only begun to emerge but to gain in significance from year to year.

Desiring to cope with the rising environmental problems, the governments of the region instituted several actions and implemented them on a priority basis. Environmental problems that had accumulated over the years have been dealt with and contained

through restorative measures backed by systematic enforcement of the various regulations while developing strategies to forestall future problems. In this respect, priority was given to controlling water pollution caused by the discharge of industrial effluents and air pollution caused by industrial and motor vehicle exhaust emissions. However the governments' efforts were hampered by lack of economically sound anti-pollution technologies and monitoring techniques and experienced and skilled staff. Therefore in 1985 the ASEAN Experts Group on the Environment identified the project on "Anti-Pollution Technologies for Urban and Rural Areas" as a priority project with emphasis on training on air quality monitoring, stack sampling, control of exhaust emission from motor vehicles and noise and vibration control and workshop on air pollution control technology. This project proposal was submitted for UNDP funding and was approved in principle. However, unfortunately, the implementation of this project had been delayed and in the meantime several other sources of funding became available which helped to implement all the activities mentioned above except training on noise and vibration control and workshop on air pollution control technology.

In the light of the above development, the ASEAN Experts Group on the Environment at its meeting held in Bangkok from 24-26 April, 1987 made an indepth review of this project and arrived at the following concensus:

(i) Duplication of efforts and wastage of resources should be avoided by ensuring that subject areas for which funds had been allotted from other donor agencies such as the EEC, JICA etc. should not be included in this project.

(ii) Emphasis should be shifted to the development of indigenous technology wherever possible and other subject areas with significant environmental impact that had not been addressed so far. In this regard discussions should be held with ASEAN member countries in identifying the priority areas.

(iii) Implementation of the various activities under the project should be undertaken by as many countries as possible with adequate institutional expertise so that the project could be completed within reasonable time and, in addition, their institutional capabilities enhanced and experience broadened.

Hence on the basis of discussions held by the Consultant with the ASEAN countries during his missions from 24-29 May and 9-30 June, the following activities have been identified and agreed as priority areas for this project:

(1) Project implementation meeting of participants from ASEAN countries that have agreed to implement the Activities under the Project for briefing on the implementation procedure and other details in order to ensure successful completion of the Activities within the time-frame stipulated.

(2) Development of indigenous technology for the handling, treatment and disposal of waste from the following industries which wherever possible should include reuse, by-product development and waste utilisation:

(a) Coconut water from desicated coconut industry and copra production

(b) Fish Processing wastes

(c) Distillery waste

(d) Piggery waste

(e) Water hyacinth - harvesting, utilisation and disposal

(f) Waste from starch production from tapioca

(g) Saw dust and wood chips from timber and wood product industry

(3) Noise pollution and vibration measurement and control technology which would essentially involve the aspect of exposure and training of officers from ASEAN member countries in countries which have developed suitable and adaptable technology.

(4) Cataloguing and documenting of air and water pollution control technologies in use in ASEAN countries starting with Singapore under this project for purposes of information exchange as well as looking into possible modification and adaptation in the future in order to make them more economically viable in the context of the ASEAN member countries situation.

(5) Air quality monitoring - Innovation and modification of air quality monitoring equipment and techniques suitable to ASEAN countries situation including the fabrication and calibration of $SO_2$ analyser and TSP sampler and the development of appropriate designs for CO, NOx and HC gas analysers as well as the development of the frame-work for a regional training centre for air quality monitoring inclusive of training scheme and materials.

In the ASEAN spirit of consensus, the responsibility for coordinating and implementing these activities has been shared out on an equitable basis among the countries, also taking into account the country situations and the rapid development in the various fields in the countries.

The justification for the selection of the above activities are based on the following factors:

(1) The common pursuit of industrialisation is a shared concern of ASEAN countries. In the region, the case for industrialisation is best appreciated when

juxtaposed with the need for corresponding growth between the young economies and the increasing population of ASEAN countries, currently home for some 250 million people. The fifth largest country in the world, Indonesia, is found in the region while two other member countries, namely, Thailand and Philippines, rank among the top 20 most populous countries in the world.

(2) Small scale industries indigenous to the region are also noted for their polluting effects. The regions lucrative fish processing and fish meal industry poses serious environmental threats. The Philippines, Thailand, Indonesia and Malaysia are among the top 13 fishing nations in the world and their promotion and management of fish processing and fish meal plants are bound to influence both the economy and the environment of the ASEAN region.

(3) Philippines is among the top exporters of the four major coconut products - copra, coconut oil, copra meal/cake and desiccated coconut. Wastewater generated by coconut processing activities is over 10 million cubic meters per year with Biochemical Oxygen Demand (BOD) ranging from 4000-6000 ppm. In Malaysia coconut-based product industries is undergoing rapid development. The major products are coconut cream powder and dessicated coconut.

(4) Proliferation of water hyacinth in the lakes and rivers of Thailand, Philippines and Indonesia has caused major environmental problems in these countries. The weed grows on massive floating clumps which in the dry season cover as much as 5% of the total area. Problems due to excessive hyacinth growth are:

(i) interference with captive fisheries and navigation

(ii) damage to fish pens especially during typhoons when floating clumps press against the pens

(iii) clogging of canals and estuaries which aggravate flooding.

No satisfactory method has so far been developed for its harvesting and disposal or utilisation.

(5) Piggery waste, specially from small farms, is a major problem in Thailand, Malaysia and the Philippines. While technology has been developed for dealing with wastes from big farms with over 10,000 heads, economically viable technology is yet to be developed for small farms with less than 500 heads which are equally significant in terms of pollution in view of the large number of such farms. In all these countries, 80% of the pig farms are small and form backyard industry causing considerable environmental problems. In Malaysia

the standing pig population is expected to increase from 1.8 million in 1986 to 2.09 million in 1990. The BOD load discharged from the pig waste industry currently in Malaysia has a population equivalent of 6.75 million people. In Philippines the standing pig population is in the region of 7.3 million.

(6) Timber industry is another source of major air pollution in all the ASEAN countries and requires immediate attention. This industry is at the same time of great economic significance to these countries. Malaysia has approximately 600 sawmills, 35 veneer factories and 900 wood-based industries operating both in urban and rural areas. About 1 million metric ton of saw dust, 1.4 million cu. meters of wood-based and 0.8 million cu. meters of bark were produced as waste in 1986. This waste has been essentially used as fuel in boilers and furnaces causing problems of dark smoke and dust emissions. Although considerable research is underway for proper utilisation of this waste without causing environmental problems such as conversion to charcoal and activated carbon, briquetting of saw dust for energy, gasification of charcoal and wood for rural electricity supply, and development of pollution free incinerators, there is no anti-pollution technology available for immediate implementation to overcome the serious pollution problems faced by the ASEAN countries from the timber industry. In the Philippines about 1.5 million cu. meters of waste are produced annually from the timber industry.

(7) Similarly distillery waste and the residue from starch production from tapioca cause serious water pollution problems due to their high B.O.D.

(8) It is a widely-held belief that expenditure in pollution control is non-productive, that it constitutes an investment without return and it is at best tying up capital for no good reason. The enterprise whether private or public tends to regard pollution control as a major financial burden to be avoided as long as possible. Particularly in the ASEAN region limited capital, lack of technically qualified personnel and space limitation hamper the adoption of anti-pollution measures by these industries. Further, these industries cannot afford the wasteful approach of treatment and disposal of their wastes, instead should convert them into useful by-products to offset the financial burden of waste disposal. In short, indigenous technology, aiming at minimising wastes produced, utilisation of wastes, material recovery and recycling, by-product production and reuse of effluent, should be developed.

(9) There is a lack of information on anti-pollution technologies for the control of air and water pollution that are being effectively used in the ASEAN countries. Cataloguing and documentation of such technologies will prove beneficial to ASEAN member countries as well as pave the way towards research into possible modification and adaptation in order to make them more economically viable.

(10) Most ASEAN member countries find air quality monitoring considerably expensive with the result that the countries have been somewhat lax in carrying out this activity. This has caused a lack of air quality data in this region. Therefore innovation and modification of air quality monitoring equipment and techniques suitable to the local situation with a view to reducing monitoring cost so as to make it affordable by ASEAN countries is an urgent need of the region. Fabrication of air quality monitoring equipment locally and the establishment of a training centre for air quality monitoring in the future are expected to reduce the cost of air quality monitoring, overcome the problem of having to purchase spare parts from overseas and help avoid interruptions of the activity due to breakdown of equipment.

(11) Noise pollution has begun to emerge as a serious problem in most cities of the ASEAN countries. The main sources of noise pollution are motor vehicles, industries, construction activities, aircraft and community. Although some efforts have been made to obtain baseline data, develop standards and formulate regulations, there is a general lack of expertise, experience and know-how with regard to measurement of noise levels and control technology. Very few seminars have been organised in this subject area so far in the ASEAN region. Therefore holding of a workshop covering all aspects of noise pollution control with participation of relevant officers from ASEAN countries is most urgent and timely.

(12) A total of 8 activities are to be implemented by various institutes in the ASEAN countries. The National Focal Points for Environmental Management in the ASEAN countries are responsible for co-ordinating the Activities. It is therefore important that an implementation meeting be held with at least two participants from each of the ASEAN countries, that have agreed to implement the Activities under the Project, being invited to attend the meeting together with a UNEP Representative. The purpose of the meeting is to brief the implementing Agencies and the National Focal Points on their role, implementation procedure and other details in order to ensure the successful completion of the Activities within the stipulated time.

More detailed background/justification are contained under the respective proposed activities in Annexes 2 to 9.

## E. Outputs

The major outputs from the activities of the project are as follows:

(a) Dissemination of information on appropriate anti-pollution technologies that have been developed and are readily available for direct application in

ASEAN member countries as well as on those that are being developed. This will help ASEAN member countries avoid unnecessary repetitive work and wastage of manpower and financial resources.

(b) Enhance the willingness and cooperation of the industries in the implementation of anti-pollution measures as well as expedite the implementation.

(c) At least 5 new self-supporting anti-pollution technologies with useful by-products will have been developed at the completion of the project.

(d) Availabality of economically viable technology will greatly facilitate the enforcement of the environmental legislations and the compliance by industries.

(e) Development of capabilities for the fabrication and maintenance of air quality monitoring equipment with techniques suitable to the local situation will greatly facilitate unhampered air quality monitoring activity and collection of meaningful data at much reduced cost. The development of a framework for a regional training centre will help solicit funds from donor countries for the establishment of the centre with a view to producing a nucleus of trained personnel in all ASEAN countries thereby achieving self-reliance in air quality monitoring.

(f) About 12 officers from the ASEAN countries will be trained in noise measurement and exposed to all aspects of noise pollution control through participating in the proposed workshop. This will pave the way for upgrading capabilities in noise pollution control in each of the ASEAN countries.

(g) Production of manuals on anti-pollution technologies, air quality monitoring techniques and equipment maintenance will considerably expedite the implementation of anti-pollution measures and help decision-making with regard to establishment of new industries. These manuals will enable ASEAN member countries to benefit from each other's achievement in anti-pollution technologies.

(h) The activities under the project will be undertaken by Research Institutes and Universities of ASEAN member countries which will help enhance institutional capabilities and expertise in the region as well as broaden their experience, thus achieving self-reliance in anti-pollution technology suitable to the local situation.

Sepecific outputs are shown in the matrix (Annex 1)

F. Activities

The major activity components of the projects are contained in Annexes 2 to 9. The summary of the Activities are as follows:

| | | |
|---|---|---|
| (a) Activity | : | Implementation Meeting |
| Coordinating Country | : | Indonesia |
| Lead Agency | : | Ministry of State for Population and Environment |
| Time Frame | : | 3 days in December 1987 |
| (b) Activity | : | Study of the Air and Water Pollution Control Technology in Singapore |
| Coordinating Country | : | Singapore |
| Lead Agency | : | Ministry of Environment |
| Time Frame | : | 2 years - January 1988 - December 1989 |
| (c) Activity | : | Training Course in Noise Pollution and Its Control in the ASEAN |
| Coordinating Country | : | Singapore |
| Lead Agency | : | Ministry of Environment |
| Time Frame | : | 4 months - January - April 1988 |

| | | |
|---|---|---|
| (d) Activity | : | (i) Treatment and Utilisation of Industrial Wastes<br>(ii) Development of Ambient Air Quality Monitoring |
| Coordinating Country | : | Philippines |
| Lead Agency | : | Industrial Technology Development Institute, Philippines |
| Time Frame | : | 2 years - January 1988 - December 1989 |
| (e) Activity | : | Development of an Anti-Pollution Wood-Waste Burner System |
| Coordinating Country | : | Malaysia |
| Lead Agency | : | Department of Environment |
| Time Frame | : | 1 year - January - December 1988 |
| (f) Activity | : | (i) Integrated Approach to Piggery Waste Pollution Control with emphasis on Biogas Production<br>(ii) Pollution Control Management for Tapioca Starch Wastewater |
| Coordinating Country | : | Thailand |
| Lead Agency | : | National Environment Board in cooperation with the Institute of Scientific and Technological Research |
| Time Frame | : | 2 years - January 1988 - December 1989 |

(g) Activity : (i) Water Hyacinth Harvesting and Management

(ii) Use of Water Hyacinth as Fertilizer and Fuel

Coordinating Country : Thailand

Lead Agency : National Environment Board

Time Frame : 18 months - January 1988 - June 1989

(h) Activity : A Workshop/Technical Meeting of Experts
Coordinating Country : To be determined in the Implementation Meeting
Lead Agency : To be determined in the Implementation Meeting
Time Frame : To be determined in the Implementation Meeting

G. Inputs

(i) Government Inputs

The Government of Indonesia will host the Implementation Meeting.

Designated national agencies of ASEAN countries will assume responsibility for the coordination and implementation of the Activities allotted. Laboratory facilities, instruments, glassware, equipment, secretarial services, vehicles, utilities, support personnel and meeting facilities will form government inputs. Staff from relevant and responsible national agencies will be provided by the governments for training and expert meetings.

Further details are given in Annex 2 to 9.

(ii) UNDP Inputs

UNDP will provide a sum of US$460,000 for preparatory assistance and for carrying out the Activities mentioned in (F) above by the respective ASEAN countries as follows:

| | | | |
|---|---|---|---|
| (a) | Preparatory Assistance | | - US$ 20,000 |
| (b) | Implementation Meeting | | - $ 8,500 |
| | Consultant for preparatory work, organisation of meeting and submission of report - 7 days | $2,100 | |
| | Travelling expenses for 8 participants | $4,000 | |
| | Daily subsistence allowance for participants for 3 days | $2,000 | |
| | Meeting expenses | $ 400 | |
| | | $8,500 | |
| (c) | Study of the Air and Water Pollution Control Technology in Singapore | | - $ 48,500 |
| (d) | Training Course in Noise Pollution and Its Control in the ASEAN | | - $ 58,000 |
| (e) | (i) Treatment and Utilisation of Industrial Wastes<br>(ii) Development of Ambient Air Quality Monitoring | | - $150,000 |
| (f) | Development of Anti-Pollution Wood-Waste Burner System | | - $ 65,000 |

| | | | |
|---|---|---|---|
| (g) | (i) Integrated Approach to Piggery Waste Pollution Control with emphasis on Biogas Production | - | $ 50,000 |
| | (ii) Pollution Control Management for Tapioca Starch Wastewater | | |
| (h) | (i) Water Hyacinth Harvesting and Management | - | $ 50,000 |
| | (ii) Use of Water Hyacinth as Fertiliser and Fuel | | |
| (i) | Workshop/Technical Meeting of Experts | - | $ 10,000 |

Details of budget allocation for the Activities are shown in Annexes 2 to 9.

(iii) UNEP Input

UNEP will provide the technical advisory services and relevant information material as needed as well as attend the project Technical Meetings at their own expense.

## II. Preparation of Work Plan

Preliminary Work Plan giving an idea of the target dates for outputs and the time required for completion is given in Annexes 2 to 9.

A more detailed Work Plan for the implementation of the project will be jointly prepared by the executing agency and the coordinating ASEAN country at the start of the project and brought forward periodically.

I. Preparation of the Framework for Effective Participation of National and International Staff in the Project

The activities to be undertaken to achieve the immediate objectives of the project will be carried out jointly or singly by the member countries of ASEAN under the auspices of the ASEAN Secretariat and with the financial support of UNDP. The respective roles of each country and the national staff to carry out activities are indicated in the Work Plan.

J. Development and Support Communication

Not applicable.

K. Institutional Framework

A networking system is proposed whereby each country is expected to nominate a lead institute to undertake a particular activity with institutes from other countries as participating institutes to provide data and other inputs. Details of the lead institutes are given in Annexes 2 to 9.

The coordination required between the executing agency and the national agencies will be ensured through a system of designated national coordinators in each ASEAN country responsible for the implementation of the particular activity components assigned to the ASEAN member countries.

The United Nations Environment Programme (UNEP) through its association with the ASEAN Experts Group on Environment since its inception has been assisting the ASEAN member countries in environmental management. In this respect the catalytic and coordinating role of UNEP and its continued commitment to giving leadership and sense of direction to environmental initiatives is commendable. UNEP will therefore provide the technical asdvisory services and information materials for this Project.

UNDP Jakarta will be the Principal Project Representative (PPR).

## L. Prior Obligation and Prerequisites

Not applicable.

## M. Future UNDP Assistance

Based on the results of this Project, additional UNDP assistance may be required for the following purposes:

(i) Establishment of Air Quality Monitoring Training Centre

(ii) Scale-up and transfer to the private sector for commercialisation of technologies developed and the fabrication, testing and operation of analysers for CO, NOx and HC gases on the basis of designs that have been developed under the Project

(iii) Extension of the Activity "Study of the Air and Water Pollution Control Technology to other ASEAN countries"

(iv) Additional workshops on noise pollution control management as a follow-up of the training course.

## PART III - SCHEDULE OF MONITORING, EVALUATION AND REPORTS

A. The project will be subject to periodic review in accordance with the policies and procedures established by UNDP for monitoring project and programme implementation.

B. The project will be subject to evaluation, in accordance with the policies and procedures established for this purpose by UNDP. The organisation, terms of reference and timing of the evaluation will be decided by consultation between the governments, UNDP and the Executing Agency.

C. Periodic progress reports will be produced by the implementing agencies in accordance with UNDP policies and procedure. A terminal report will be produced by the implementing agencies for each Activity upon its completion and submitted to UNDP Jakarta for distribution.

## PART IV - BUDGET

The Project budget covering UNDP contribution amounting to US$430,000 excluding preparatory assistance of $20,000 is given in Annex 10. Budgets for the individual Activities are contained in Annexes 2 to 9.

## BASIC PROJECT ELEMENTS FRAMEWORK

### Immediate Objectives

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| (a) To ensure duplication of efforts and wastage of funds are avoided in alleviating common environmental problems. | This objective will be considered successfully carried out if:<br>(1) ASEAN member countries have full knowledge on each others environmental activities;<br>(2) appropriate means have been deviced and utilised for information exchange in a regular basis;<br>(3) appropriate conditions have been stipulated for the allocation of funds for any study or research at the national level. | (1) With regard to this report from the national focal point in each of the ASEAN countries and the report of the meetings of the ASEAN Experts Group on Environment would be the verifier.<br>(2) Could be verified by the existence of news-letters, manuals, manual reports and proceedings of seminars and dialogue sessions and statistics on visits of technical staff.<br>(3) Could be verified by the type of machinery for approval of funds, the contents of the application form and national budget proposals. | (1) Change of policy brought about by change of government resulting in change in national priorities.<br>(2) Change of national counterparts due to transfer, promotion, retirement, resignation etc.<br>(3) General socio-economic conditions. |

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| (b) To minimise the financial burden of the industry in the implementation of anti-pollution measures. | This objective will be considered successfully carried out if:<br>(1) Industry is provided with the know-how of utilising the waste usefully and allied industries are developed successfully to produce marketable by-products.<br>(2) Industry is motivated and compelled to adopt resource conservation rather than treating the waste and dumping into the environment by convincing that there is money in the waste.<br>(3) Appropriate legislations and policies to this end have been formulated and enforced. | (1) Could be verified by the existence of manuals and availabality of products both in the local and international markets and reports of Enforcement Authorities.<br>(2) Could be verified from reports on progress in implementation of anti-pollution technologies by industry and national environmental quality reports.<br>(3) Could be verified from the National Enforcement Authorities. | (1) The same external factors as for objective (a) will apply.<br>(2) Market conditions and competing alternatives or substitutes could affect the demand for by-products. |

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| (c) To re-inforce national capabilities in the region in the enforcement of pollution control regulations. | This objective will be considered successfully carried out if: | | The same external factors as for objective (a) will apply. |
| | (1) Enforcement Authorities are equipped with economically viable technology to meet the standards stipulated in the Regulations. | With regard to (1) the number of cases of non compliance by industry would be the verifier. | |
| | (2) Industrial development is not hampered by having to comply with stringent legislations without the appropriate technological means. | (2) Could be verified by the number of industries that have received approval. | |
| | (3) Enforcement staff have acquired full knowledge of the anti-pollution technologies. | (3) Could be verified through reports from supervisors of enforcement staff. | |

| | Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|---|
| (d) | To develop monitoring techniques suitable to the local situation and upgrade capabilities within the region with regard to fabrication and maintenance of air quality monitoring equipment including the development of the framework for a regional training centre for air quality monitoring. | This objective will be considered successfully carried out if:<br>(1) Simplified, cost effective techniques have been developed for air quality monitoring in the region.<br>(2) Sufficient locally fabricated air quality monitoring equipment are made available at reasonable cost in the shortest possible time.<br>(3) Appropriate plans have been prepared for the training centre with details of facilities required, training scheme and training materials. | With regard to (1) enhanced air quality monitoring activity with availability of sufficient and meaningful air quality data would be be the verifier.<br>(2) Could be verified by the extent to which locally fabricated equipment have been put to use in each of the ASEAN countries.<br>(3) Evaluation by a technical experts group will be the verifier. | (1) The same external factors as for objective (a) will apply.<br>(2) Receptivity to change /innovation.<br>(3) Equipment availability, supply and maintenance.<br>(4) Cost-effectiveness due to quantity of equipment needed for the region. |

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| (e) To upgrade capabalities within the region in the field of noise pollution control and management. | This objective will be considered successfully carried out if: | | The same external factors as for objective (a) will apply. |
| | (1) All ASEAN member countries carry out noise measurement and noise pollution survey, formulate and enforce appropriate regulations. | (1) Could be verified by reference to the environmental management programmes and reports of Enforcement Authorities in ASEAN member countries. | |
| | (2) At least 5 to 6 trained officers are available in each ASEAN country to implement noise pollution control programme. | (2) The verifiers will be:<br>(i) Enforcement Authorities report on the trainers' knowledge in this field.<br>(ii) Report of the training workshop. | |
| | (3) Workshops and seminars are held regularly to exchange experience and know-how and upgrade knowledge and expertise. | (3) Could be verified by reference to the training programme of the Enforcement Authority of each country. | |

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| (f) To make available manuals on anti-pollution technologies, air quality monitoring techniques and equipment maintenance and organise training workshops on the use of the manuals. | This objective will be considered successfully carried out if:<br>(1) Practical manuals have been prepared and extensively utilised by the ASEAN member countries.<br>(2) Industries have found it beneficial in implementing their anti-pollution technologies.<br>(3) Enforcement staff have acquired sufficient knowledge to enforce the legislations successfully.<br>(4) Research Institutions in ASEAN countries have enhanced their expertise and capabilities.<br>(5) Air quality monitoring activity have progressed smoothly at reasonable cost and it has been possible to obtain useful and meaningful data in all ASEAN countries. | With regard to (1) the verifiers will be:<br>(i) the demand for the manuals.<br>(ii) establishment of air quality monitoring network in all the ASEAN countries.<br>(iii) frequency of equipment breakdown.<br>(2) Will be verified by the progress in implementation of anti-pollution technologies.<br>(3) Will be verified by the reduction in number of prosecutions for failure to meet standards stipulated in the legislations.<br>(4) Will be verified by the degree of self-reliance achieved.<br>(5) Will be verified through reports of enforcement agencies. | The same external factors as for objective (a) will apply. |

**Outputs**

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| In relation to objective (a) | | | |
| (1) Information material on anti-pollution technologies available for direct application in ASEAN countries as well as on research efforts in progress in the region. | (1) Waste of funds and human resources due to repetitive work has been avoided. | (1) Report of the ASEAN Experts Group on Environment will be the verifier. | As in the Immediate Objectives. |
| (2) Network of Research Institutes capable of undertaking technology development in the ASEAN region. | (2) At least one Research Institute in each ASEAN country have upgraded its capabilities and broadened its scope. | (2) Evaluation by an external expert will be the verifier. | |
| (3) Cadre of trained and experienced personnel in each ASEAN country. | (3) Several researchers in each ASEAN country have widened their knowledge and skills. | (3) Director's report on achievements will be the verifier. | |

Outputs

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| In relation to objective (b) | | | |
| (1) At least 5 new self-supporting anti-pollution technologies with useful by-products available for impelementation by industries. | (1) Willingness and co-operation of the industry in the implementation of anti-pollution technologies. | (1) Increase in the number of factories that have installed anti-pollution technologies and the rate of complaince with the legislations will be the verifiers. | As in the Immediate Objectives. |
| (2) Several marketable by-products. | (2) Resource conservation and zero effluent discharge have been achieved and cost of anti-pollution measures offset. | (2) Improvement in environmental quality and reduction in financial burden will be the verifiers. | |

Outputs

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| In relation to objective (c) | | | |
| (1) Cadre of enforcement officers equipped with economically viable anti-pollution technology in each ASEAN country. | (1) More efficient performance of enforcement activity. | (1) Rate of compliance and the number of prosecutions will be the verifiers. | As in the Immediate Objectives. |
| (2) Smoother enforcement of environmental legislations. | (2) Factories have no means of substantiating non-compliance. | (2) Progress in implementation of anti-pollution technology will be the verifiers. | |

Outputs

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| In relation to objective (d) | | | |
| (1) Locally fabricated air pollution monitoring equipment and maintenance manual for $SO_2$ analyser and TSP sampler. | (1) Enhanced air quality monitoring activity in all ASEAN countries at reduced cost has been achieved. | (1) Verifier will be the report of the ASEAN Experts Group Meeting on Environment. | As in the Immediate Objectives. |
| (2) Appropriate designs for CO, NOx and HC gases, training centre plan, training scheme and materials. | (2) Plans and designs have been used to establish the training centre and fabricate monitoring equipment. | (2) Verifier will be the report of the ASEAN Experts Group Meeting on Environment. | |
| (3) Manual of air quality monitoring techniques suitable to the local situation. | (3) A manual containing air quality monitoring techniques have been prepared, field-tested and adopted by ASEAN countries. | (3) The verifier will be the report of the ASEAN Experts Group Meeting on Environment. | |

**Outputs**

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| In relation to objective (e) | | | |
| (1) Cadre of trained officers in noise pollution measurement in each ASEAN country. | (1) At least 2 person from each ASEAN country will have acquired the necessary expertise. | (1) Report of the Training Workshop will be the verifier. | As in the Immediate Objectives. |
| (2) National agencies with expertise necessary for training more personnel in noise pollution control and management. | (2) The national agency designated as the training centre in each ASEAN country have acquired necessary expertise and capabilities of conducting training course in their own country and if needed, for trainees from other ASEAN countries. | (2) Evaluation by an external expert or report of the ASEAN Experts Group Meeting on Environment will be the verifiers. | |

Outputs

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| In relation to objective (f) | | | |
| (1) Manuals on anti-pollution technologies, air quality monitoring techniques and equipment maintenance | (1) Manuals have been formulated and printed which contain complete information on anti-pollution technologies air quality monitoring techniques and equipment maintenance and adopted by the ASEAN countries. | (1) Evaluation by a technical meeting of experts from ASEAN countries will be the verifier. | As in the Immediate Objectives. |
| (2) Cadre of personnel in each ASEAN country fully familier with the use of the manuals. | (2) At least two to three persons from each ASEAN country have participated in a training workshop on the use of the manuals. | (2) Report of the training workshop will be the verifier. | |

**Inputs**

| Project Elements | Success Criteria | Verifiers | External Factors |
|---|---|---|---|
| (1) Local project consultants from ASEAN countries to provide technical expertise. | (1) Consultants have substantial experience and a good sense of creativity. | (1) Personal history of the consultants will be the verifier. | (1) Government approval for choice of consultants. |
| (2) Part-time and full-time technical staff for field work, testing and developmental work from implementing agencies. | (2) Technical staf have extensive experience of undertaking similar assignment and show a good sense of cooperation. | (2) Reports and publications from the implementing agencies will be the verifier. | (2) Timing of project implementation in relation to availability of personnel and other resources. |
| (3) Equipment and materials for research activities, pilot plant etc. | (3) Equipment and materials are properly chosen and available on time. | (3) Reports/comments by the party using the equipment and materials. | |
| (4) Suitable participants for training workshops and experts meetings. | (4) Availability of qualified candidates and experts. | (4) Position, experience and qualifications of candidates. | |
| (5) UNDP Funding. | (5) Availability of sufficient funds which are released without delay. | (5) Agreement by UNDP will be the verifier. | |
| (6) UNEP Input. | (6) Technical advice and information materials have been provided for the project. | (6) Report of the ASEAN Experts Group Meeting on Environment will be the verifier. | |
| (7) Government support from ASEAN countries. | (7) Willing cooperation to extend facilities, information, data and other assistance. | (7) Letters of Authority from the Governments will be the verifier. | |

ACTIVITY : STUDY OF THE AIR AND WATER POLLUTION CONTROL TECHNOLOGY IN SINGAPORE

1. BACKGROUND AND JUSTIFICATION

The economic development of ASEAN countries has reached the stage where industrialisation is beginning to assume a significant role in their economies. One inevitable consequence of industrialisation is industrial pollution. If pollution from the industries is not properly controlled at an early stage, the environment and public health would suffer. Pollution control measures can be very costly and every effort should be made to make maximum use of materials and expertise available locally to achieve maximum control at minimum cost. Singapore has been chosen for the Project because it is one of the first among the ASEAN countries to industrialise on a large scale. At present, the country has a very diverse range of industries operating within its industrial estates. Basic information on these industries is already available and collection of additional information for the Project is facilitated by the concentration of factories within industrial estates and the communication infrastructure available in the country.

This Project is an ASEAN priority project and can be implemented almost immediately. In the ASEAN context, it is geared to promoting technical co-operation in the field of pollution control with the ultimate objective of preserving and improving the environment.

This Activity will enable ASEAN countries to learn from each other's experience and to identify the most cost-effective solutions to environmental pollution problems. It also meets the broader objective of making maximum use of locally available materials, expertise and technology to control pollution from industries at minimum cost.

2. ACTIVITY OBJECTIVE

The Project is designed to make a start to the documentation of pollution control technology in the various ASEAN countries starting with Singapore. Ultimately, the objective is to promote the exchange of information on air and water pollution control technology for various types of industries within the ASEAN countries. The exchange of information can culminate in the preparation of a manual of pollution control technology which is both practical and cost-effective for various industries in the ASEAN region. The Project will help to foster co-operation and understanding between the various pollution control authorities in the region in the long run.

This Activity would enable the ASEAN countries starting with Singapore:

(i) to inventorise the air and water pollution control technology used in the various industries;

(ii) to identify the most cost-effective and practical methods of pollution control for each industry;

(iii) to take stock of the materials and expertise available locally for industrial pollution control; and

(iv) to promote collaboration between government agencies and research organisations in the compilation of information on pollution control technology available locally.

3. OUTPUT

Inventory of the types of industries in operation, their pollution problems and the control technology adopted in Singapore including the cost element wherever possible.

4. ACTIVITY COMPONENTS

(i) To conduct a study which will be done by the National University of Singapore and supervised by the Ministry of the Environment, Singapore, on existing pollution control technology.

(ii) To prepare a report detailing the types of industries operating locally, the processes involved, the pollutants and wastes generated and the pollution control technology adopted to abate pollution including the cost element wherever possible.

5. INPUTS

(a) Government Inputs

The Ministry of the Environment will engage a research organisation (the National University of Singapore) to carry out the study and provide support in the form of supervision, provision of technical information, liaison with industries and all other assistance necessary to enable the organisation to complete the Project. The Ministry will be the local agency in this Project.

(b) UNDP Inputs

Financial support from UNDP will be as follows:

| | |
|---|---|
| Personnel (24 man-months) | US$36,000 |
| Computer (one IBM PC + accessories) | 2,500 |
| Transport (Field Visits) | 4,000 |
| Stationery/Consumables | 500 |
| Measurement/Analysis | 2,500 |
| Final Report/Interim Reports | 3,000 |
| Total: | US$48,500 |

6. WORK PLAN

As given in Annex 2(a).

7. INSTITUTIONAL FRAMEWORK

This Activity will be implemented by the Ministry of Environment, Singapore with consultants provided by the National University of Singapore.

8. BUDGET

The Budget covering UNDP contribution is given in Annex 2(b).

Annex 2(a)

# WORK PLAN

COORDINATING COUNTRY : SINGAPORE

ACTIVITY : STUDY OF THE AIR AND WATER POLLUTION CONTROL TECHNOLOGY IN SINGAPORE

| ACTIVITIES | 1988 | | | | | | | | | | | | 1989 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mac | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mac | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 1. Prepatory Work | x | x | x | | | | | | | | | | | | | | | | | | | | | |
| 2. Field Visits, Collection of Information, Data processing, Measurement, Analysis of Survey Data etc. | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | | | |
| 3. Compilation of Final Report | | | | | | | | | | | | | | | | | | | | | | x | x | x |

# BUDGET COVERING UNDP CONTRIBUTION
## (US DOLLARS)

COORDINATING COUNTRY : SINGAPORE

ACTIVITY : STUDY OF THE AIR AND WATER POLLUTION CONTROL TECHNOLOGY IN SINGAPORE

| 10 PROJECT PERSONNEL | TOTAL | | 1988 | | 1989 | |
|---|---|---|---|---|---|---|
| | m/m | $ | m/m | $ | m/m | $ |
| 17. National Professionals | 24 | 36,000 | 12 | 18,000 | 12 | 18,000 |

| 40 EQUIPMENT | TOTAL $ | 1988 $ | 1989 $ |
|---|---|---|---|
| 41 Expendable Equipment | 500 | 250 | 250 |
| 42 Non-Expendable Equipment | 2,500 | 2,500 | - |

| 50 MISCELLANEOUS | | | |
|---|---|---|---|
| 51 Reporting Costs | 3,000 | - | 3,000 |
| 52 Sundry | 6,500 | 3,500 | 3,000 |

| Total For Activity | 48,500 | 24,250 | 24,250 |
|---|---|---|---|

ACTIVITY : TRAINING COURSE IN NOISE POLLUTION AND ITS CONTROL IN ASEAN

1. BACKGROUND AND JUSTIFICATION

Apart from the obvious advantages, economic development also brings with it certain undesirable consequences such as air pollution, water pollution and noise pollution. While air and water pollution have been subject to control for quite some time within the rapidly developing ASEAN countries, the control of noise pollution has not been given the same emphasis. Perhaps it is because noise pollution is not perceived, albeit wrongly, to be as hazardous to health as air and water pollution. Another reason is the lack of trained personnel to carry out an effective noise control programme. The need for such a programme within ASEAN grows greater by the day as the number of noise-induced deafness cases continues to mount.

All the ASEAN countries have agreed that the training of personnel in noise pollution measurement and control should be given top priority. The project can be implemented immediately.

This Activity reponds to the critical need of ASEAN to train their staff in noise pollution control so as to establish comprehensive noise control programmes in their respective countries. It also ties in with the overall environmental protection of the ASEAN countries.

2. ACTIVITY OBJECTIVE

This Activity is designed to provide enforcement officers in ASEAN countries with the necessary training to carry out noise measurement and to control noise emission. Expertise in noise pollution measurement and control is lacking among the ASEAN enforcement agencies and this Project is designed to produce a corps of trained noise pollution control officers who could then return to their respective countries to set up noise control programmes and impart their knowledge and skill to other enforcemnt officers. The ultimate objective is to initiate control of noise pollution on a comprehensive scale in all ASEAN countries and hence protect the living environment and the health of the populace.

This Activity would enable officers of the relevant authorities in the ASEAN:

(i) to be trained in noise pollution, measurement and control;

(ii) to have hands-on experience in the use of various types of instruments for the measurement and analysis of noise; and

(iii) to meet with and learn from the experiences of noise experts and counterparts in the ASEAN region.

3. OUTPUT

A cadre of trained personnel in noise pollution control management and a reference manual for use by the trainees.

4. ACTIVITY COMPONENTS

(i) To organise a training course for a group comprising 2 trainees from each ASEAN country on noise pollution control. The course will be conducted by 2 noise experts from the National University of Singapore and will cover topics such as the nature of sound, types of noise sources, noise surveys, methods of noise measurement, noise attenuation and noise pollution control measures. Case studies and practical sessions (to give students hands-on experience in the use of various noise measurement and analysis equipment) will also be included in the course.

(ii) To prepare a course manual for the trainees. The manual for the course will be very comprehensive and will be designed to serve as a reference to the trainees in their work as noise pollution control officers after the completion of the course.

5. INPUTS

(a) Government Inputs

Participating counries are required to nominate 2 candidates for the training course. The lead agency will be the Ministry of the Environment, Singapore.

(b) UNDP Inputs

Financial support amounting to US$58,000 as follows:

| | |
|---|---|
| Return air fare for 10 ASEAN trainees (excluding Singapore trainees) at US$350 each | US$ 3,500 |
| Living expenses for 10 ASEAN trainees (excluding Singapore trainees) at US$100 each for the 3-week course (19 days) | 19,000 |
| Noise Experts | 12,000 |
| Technical support staff | 1,500 |
| Noise measurement equipment | 15,000 |
| Laboratory charges/facilities charges/consumables for instruments | 3,000 |
| Production of course materials | 2,000 |
| Transport (for field sessions) | 1,000 |
| Sundry | 1,000 |
| | US$58,000 |

6. WORK PLAN

As given in Annex 3(a)

7. INSTITUTIONAL FRAMEWORK

This Activity will be implemented by the Ministry of Environment, Singapore responsible for all aspects of environmental management, with two experts provided by the National University of Singapore.

8. BUDGET

The budget covering UNDP contribution is given in Annex 3(b).

# WORK PLAN

COORDINATING COUNTRY : SINGAPORE

ACTIVITY : TRAINING COURSE IN NOISE POLLUTION AND ITS CONTROL IN ASEAN

| ACTIVITIES | 1988 | | | |
|---|---|---|---|---|
| | January | February | March | April |
| 1. Prepation of Course Materials | x | x | x | |
| 2. Training Course | | | | x (three weeks from 11-29) |

## BUDGET COVERING UNDP CONTRIBUTION
## (US DOLLARS)

COORDINATING COUNTRY : SINGAPORE

ACTIVITY : TRAINING COURSE IN NOISE POLLUTION AND ITS CONTROL IN ASEAN

| | | TOTAL | | 1988 | |
|---|---|---|---|---|---|
| 10 | PROJECT PERSONNEL | m/m | $ | m/m | $ |
| | 17. National Professionals | 8 | 12,000 | 8 | 12,000 |
| 13 | Support Personnel | 1½ | 1,500 | 1½ | 1,500 |
| | | TOTAL $ | | 1988 $ | |
| 30 | TRAINING | | | | |
| | 31 Training | 22,500 | | 22,500 | |
| 40 | EQUIPMENT | | | | |
| | 41 Expendable Equipment | 5,000 | | 5,000 | |
| | 42 Non-Expendable Equipment | 15,000 | | 15,000 | |
| 50 | MISCELLANEOUS | | | | |
| | 52 Sundry | 2,000 | | 2,000 | |
| Total For Activity | | 58,000 | | 58,000 | |

ACTIVITY : TREATMENT AND UTILISATION OF INDUSTRIAL WASTES

1. BACKGROUND AND JUSTIFICATION

The cultivation, harvesting, and processing of agricultural and marine products constitutes an important sector of the Philippine economy. The coconut and sugar industries have traditionally supplied a major fraction of the country's foreign exchange earnings, and marine products are an important source of protein to the general population. This sub-project addresses some of the environmental pollution problems associated with these three industries.

The Philippines is the world's largest producer of coconuts, most of which are processed into copra, and thence to coconut oil, or into dessicated coconut. The processing of coconuts into these products is accompanied by the discharge of coconut water, which has a very high biochemical oxygen demand (BOD). The country's seven dessicated coconut factories each discharge 60,000 to 480,000 liters of coconut water daily, and copra producers contribute a much higher volume.

Coconut water contains fats, protein, and minerals and is therefore of some nutritional value. In fact, the water obtained from young coconuts is consumed as a summer drink. The best method of utilizing the coconut water waste, therefore, would be to return it into the food chain at the highest possible level, preferrably for human consumption. However, coconut water from mature nuts, which are used for copra and dessicated coconut production, is less appealing in flavour than that from young nuts, so this pattern of utilization is not readily available for coconut water waste.

The National Institute of Science and Technology (now ITDI) has developed a technology for processing the coconut water waste into carbonated and non-carbonated beverages. The technology has been commercialized, to a limited scale, by a local beverage company. The flavour of the product, however, does not compare to that of fresh water from young coconuts, and its acceptability in the domestic market is therefore limited.

Commercialization of the coconut watr beverage technology also brought to light another problem. The beverage company received a number of orders for the product from foreign clients, which they were unable to meet because the coconut water would spoil during shipment from the collection point to the processing and packaging facility, due to the very rapid rate of microbial degradation. In order for coconut water waste to be utilized extensively for beverage production, appropriate methods and equipment will have to be developed to pretreat and preserve the coconut water prior to shipment and final processing, or to carry out the processing at the collection point prior to shipment for packaging and distribution. This strategy will be adopted because the target recipients of the technology will be established food and beverage companies with established channels of distribution.

Currently, a limited amount of coconut water is utilized for the production of vinegar and other fermented foods. However, the lengthy fermentation period required discourages entrepreneurs from venturing into this industry because of the long turn-around time.

Fish processing involves the preservation of fish by different methods, mainly canning, for domestic and foreign consumption. The industry provides an

important source of protein to the local population, and makes significant contribution to the economy, with 26.2 million metric tons of processed fishery products, valued at over $49 million, exported in 1985.

Solid wastes are generated at the very start of the process in the form of trash fish, which are rejected from the rest of the catch because they are bony or otherwise unappealing to consumers. Additional solid wastes are generated in cleaning and evisceration of the fish prior to canning. Liquid wastes, known as canning broths, are also generated during canning when the fish are steamed. A typical fish cannery can process 50 tons/day of fish and generates 20 tons of solid wastes and 36 tons of canning broths.

The solid wastes and the canning broths may be utilized in the production of condiments, fish paste and fish sauce, through solid state fermentation and protein hydrolysis. A more common method of utilizing the solid waste is to convert this into fish meal for use as animal feed. However, the solid waste must first be pressed to reduce its moisture content and expell the oils which may cause the development of rancidity in the fish meal. The aqueous fraction of the liquid thus obtained can again be used to produce condiments, but no use has been found for the fatty fraction, which poses a considerable disposal problem since it quickly becomes rancid and develops a foul odor.

The sugar industry, on the other hand, is the precursor of the ethanol industry in the sense that its major by-product, molasses, is used as fermentation feedstock for ethanol production. The proposed National Ethanol Program, which calls for the production of 100 million liters of anhydrous ethanol annually, will also

generate 1.25 billion liters of distillery slops. There are currently twenty alcohol distilleries in the country, which each generate 160,000 to 680,000 liters of slops daily. Distillery slops have a BOD of 35,000 mg/l.

The slops are obtained as a distillation by-product during separation of the ethanol from the beer, and thus contain fermentation by-products, such as aldehydes, ketones, and organic acids, as well as unfermented substrate, invert sugars, and other nutrients such as ammonia and phosphorus. This constituents account for the high organic load of the slops.

Current practice among alcohol distilleries consists of reducing the organic load of the slops to acceptable levels. This treatment traditionally has been carried out under aerobic conditions, although current trends now favour anaerobic treatment because the latter has lower power requirements and is accompanied by the generation of biogas, which can be used as a supplementary fuel by this energy-intensive industry.

While distilleries are able to meet the effluent standards for BOD and suspended solids using these treatment methods, the requirement for colour cannot be met. For this reason, direct discharge of the effluent into the river system is not allowed. Instead, the slops are usually discharged onto land as irrigation water. This method of final disposal has proven costly to distilleries which are located some distance from agricultural lands; conventional methods of decolorization, involving physico-chemical processes, are also quite costly, but the ITDI has done some preliminary work on the microbial decolorization of distillery slops, which may prove to be economically attractive because minimal operating inputs are required and the process may be used in conjunction with anaerobic treatment.

While land irrigation returns some of the nutrients contained in the slops into the food chain, it may also be possible to utilize the slops as an animal feed supplement after some simple concentration and separation processes, so that recovery of the nutrients is enhanced.

2. ACTIVITY OBJECTIVE

To develop indigenous anti-pollution technologies for treatment and utilization of coconut water, wastes from fish processing factories and distillery slops.

3. OUTPUT

(i) Marketable products from coconut water, fish processing wastes and distillery slops.

(ii) Technology for treatment of the wastes to acceptable quality and microbial decoloration of distillery wastes.

4. ACTIVITY COMPONENT

(a) Coconut Water

(i) Development of Formulated Coconut Water Beverages and Mobile Pretreatment/Processing Technology.

(ii) Development of Accelerated Vinegar Production Technology.

(ii) Development of Alternative Technologies for the Treatment and Utilization of Coconut Water Waste.

(b) Fish processing Wastes

(i) Upgrading of trash fish and cannery wastes into foods and feeds.

(ii) Utilization of fish oils obtained as by-product of fish meal production.

(c) Distillery Slops

(i) Utilization of distillery slops for animal feeds.

(ii) Decolorisation of distillery slops by microbial methods.

(d) Others

(i) Economic evaluation of technologies developed.

(ii) Publication of technical information dissemination materials.

(iii) Preparation of terminal report.

5. INPUTS

(a) Government Inputs

The Industrial Technology Development Institute (ITDI) will provide the facilities and staff for the activity. The National Environmental Protection Council (NEPC) and the National Pollution Control Commission (NPCC) will assist in the coordination of the Activity as well as in setting of performance targets for the treatment

technologies and monitoring in accordance with current effluent standards and air quality requirements. Additional inputs of raw materials and labour will be solicited from cooperating companies selected for providing pilot plant sites.

(b) UNDP Inputs

Financial support amounting to US$93,600 will be provided by UNDP as follows:

| | |
|---|---|
| Project Personnel and Administrative Support (Technical Assistance, Clerical Staff etc.) | US$29,600 |
| Travelling Expenses | 4,500 |
| Supplies and Materials | 25,000 |
| Equipment | 3,500 |
| Sundry | 3,000 |
| | US$93,600 |

6. WORK PLAN

As given in Annex 4(a).

7. INSTITUTIONAL FRAMEWORK

The Industrial Technology Development Institute (ITDI) shall be the lead agency for the project as it possesses the capability to conduct research and development work and perform testing and analytical services. The ITDI, formerly known as the National Institute of Science and Technology, is the country's oldest industrial research institution and thus has established extensive research capabilities and a track record of successful research undertakings. One of the Institute's technical divisions, the Environment Division, is devoted to research on industrial pollution control, waste utilization and resource recovery, and environmental impact assessment, prediction, and monitoring methodologies. The ITDI will undertake the research component of the project.

Other participating agencies are the National Environmental Protection Council (NEPC) and the National Pollution Control Commission (NPCC). The NEPC is responsible for the development of policy and legislation to ensure the maintenance of a sound environment, and the review and licensing of infrastructure and industrial projects which may have considerable environmental impact. The NPCC, on the other hand, is concerned with the enforcement of environmental pollution regulations, and also performs air and surface water quality monitoring to determine pollutant levels. Both agencies will provide coordinative and technical support to the project.

8. BUDGET

Budget covering UNDP contribution is given in Annex 4(b).

WORK PLAN

Annex 4(a)

COORDINATING COUNTRY : PHILIPPINES

ACTIVITY : TREATMENT AND UTILISATION OF INDUSTRIAL WASTES

| ACTIVITIES | PROJECT MONTH 1988 J | F | M | A | M | J | J | A | S | O | N | D | 1989 J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) Treatment and Utilization of Coconut Water Waste | | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Development of Formulated Coconut Water Beverages and Mobile Pretreatment/Processing Technology | | | | | | | | | | | | | | | | | | | | | | | | |
| o survey of coconut water collection facilities at copra and dessicated coconut manufacturing plants | * | * | | | | | | | | | | | | | | | | | | | | | | |
| o determination of appropriate pretreatment/ processing methods according to final processing requirements | | * | * | | | | | | | | | | | | | | | | | | | | | |
| o development and testing of various flavored coconut water beverage formulations | | * | * | * | * | * | * | | | | | | | | | | | | | | | | | |
| o process development | | | | * | * | * | * | * | * | | | | | | | | | | | | | | | |
| o equipment design, fabrication and testing | | | | | | * | * | * | * | * | * | * | * | | | | | | | | | | | |
| o product marketability, storage and packaging studies | | | | | | | | | | | | | | | | | | * | * | * | * | * | * | |
| (2) Development of Accelerated Vinegar Production Technology | | | | | | | | | | | | | | | | | | | | | | | | |
| o process development and optimization | * | * | * | * | * | * | * | * | | | * | * | | | | | | | | | | | | |
| o technology transfer | | | | | | * | * | * | | | | | * | * | * | | | * | * | * | | | | |
| (3) Development of Alternative Technologies for the Treatment and Utilization of Coconut Water Waste | | | | | | | | | | | | | | | | | | | | | | | | |
| o characterization studies | * | * | | | | | | | | | | | | | | | | | | | | | | |
| o literature survey on technologies for the recovery/preparation and utilization of various components or formulation of coconut water | * | * | * | | | | | | | | | | | | | | | | | | | | | |
| o laboratory to bench-scale process development studies | | | * | * | * | * | * | * | * | * | * | * | * | | | | | | | | | | | |
| (b) Treatment and Utilization of Fish Processing Wastes | | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Upgrading of Trash Fish and Cannery Wastes into Foods and Feeds | | | | | | | | | | | | | | | | | | | | | | | | |
| o product development and testing | * | * | * | * | * | * | * | * | * | * | * | * | | | * | * | | | | | | | | |
| o technology transfer | | | | | | | | | | | | | * | * | * | | | * | * | * | | | | |
| (2) Utilization of Fish Oils Obtained as By-Product of Fish Meal Production | | | | | | | | | | | | | | | | | | | | | | | | |
| o characterization studies | * | * | | | | | | | | | | | | | | | | | | | | | | |
| o development of oil refining process | | * | * | * | * | * | * | * | | | | | | | | | | | | | | | | |
| o development of products and processes for utilization of refined oil | | | | * | * | * | * | * | * | * | * | * | * | | | | | | | | | | | |
| o technology transfer | | | | | | | | | | | | | | | * | * | * | * | | | | | | |

| ACTIVITIES | PROJECT MONTH 1988 J | F | M | A | M | J | J | A | S | O | N | D | 1989 J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (c) Treatment and Utilization of Distellery Slops | | | | | | | | | | | | | | | | | | | | | | | | |
| (1) Utilization of Distillery Slops for Animal Feeds | | | | | | | | | | | | | | | | | | | | | | | | |
| o characterization of slops, in terms of nutritional value and to determine processing requirements | * | * | | | | | | | | | | | | | | | | | | | | | | |
| o process development and limited-scale production | | * | * | * | * | * | * | * | * | | | | * | * | | | | * | * | | | | | |
| o feed formulation and animal feeding trials | | | | | | | | | | * | * | * | | | * | * | * | | | | * | * | * | |
| (2) Decolorization of Distillery Slops by Microbial Methods | | | | | | | | | | | | | | | | | | | | | | | | |
| o laboratory determination of biochemical process parameters | * | * | * | * | * | * | | | | | | | | | | | | | | | | | | |
| o process development, for possible scale-up | | | | | | | * | * | * | * | * | * | * | * | | | | | | | | | | |
| o process cost estimation | | | | | | | | | | | | | | | * | * | | | | | | | | |
| (d) Terminal Activities | | | | | | | | | | | | | | | | | | | | | | | | |
| o economic evaluation of technologies developed | | | | | | | | | | | | | | | | | | | | * | * | * | * | * |
| o publication of technical information dissemination materials | | | | | | | | | | | | | | | | | | | | * | * | * | * | * |
| o preparation of terminal report | | | | | | | | | | | | | | | | | | | | | * | * | * | * |

# BUDGET COVERING UNDP CONTRIBUTION
## (US DOLLARS)

COORDINATING COUNTRY : PHILIPPINES

ACTIVITY : TREATMENT AND UTILISATION OF INDUSTRIAL WASTES

| | | TOTAL | | 1988 | | 1989 | |
|---|---|---|---|---|---|---|---|
| | | m/m | $ | m/m | $ | m/m | $ |
| 10 | PROJECT PERSONNEL | | | | | | |
| | 17. National Professional | 1 | 1,000 | ½ | 500 | ½ | 500 |
| 13 | Administrative Support Personnel | 208 | 28,600 | 104 | 14,300 | 104 | 14,300 |
| 40 | EQUIPMENT | | | | | | |
| | 41 Expendable Equipment/Supplies | | 25,000 | | 20,000 | | 5,000 |
| | 42 Non Expendable Equipment | | 31,500 | | 31,500 | | |
| 50 | MISCELLANEOUS | | | | | | |
| | 51 Reporting Cost | | 3,000 | | - | | 3,000 |
| | 53 Sundry | | 4,500 | | 4,000 | | 500 |
| Total For Activity | | | 93,600 | | 71,300 | | 22,300 |

ACTIVITY : DEVELOPMENT OF AMBIENT AIR QUALITY MONITORING EQUIPMENT

1. BACKGROUND AND JUSTIFICATION

Air pollution is emerging as a major environmental issue especially in the urban areas and in the rural fringes of industrial concerns in the Philippines. Potential polluters are industries that burn fossil fuels and motor vehicles that are diesel or gasoline powered. There are about 85,000 establishments in the country according to the 1981 report of the National Census and Statistics Office. About 18% of these are located in Metro Manila. As of 1986, a total of 5,772 industrial plants throughout the country have been surveyed by the National Pollution Control Commission (NPCC). Of the 3,289 potential air polluters identified, 90% are reported to have installed adequate air pollution control facilities.

In Metro Manila, industrial plants account for 95.4% of the sulfur dioxide, 50.1% of the total particulate matter, 1.1% of the carbon monoxide, and 9.6% of the hydrocarbons discharged into the atmosphere. The remaining pollutant load emmanates from the 471,000 motor vehicles plying Metro Manila streets. For the period 1982-1983, there were observed decreases in the atmospheric concentration of carbon monoxide and sulfur dioxide in some areas in Metro Manila. Some monitoring stations, however, recorded exceedances in the hourly suspended particulate standard. In areas outside Metro Manila, the air pollution threat is posed primarily by geothermal and coal-fired power plants.

In the light of this concern, there is clear recognition of the need for a meaningful and cost-effective air quality monitoring system in the country. The system would basically aim to:

- determine the levels and trends of air pollution in the country;
- detect concentration levels which would have adverse effects on humans and ecosystems;
- provide basic data for standard setting and compliance monitoring in air pollution control; and
- generate data on which policies relative to air quality management could be based.

In the Philippines, the NPCC is the agency charged with the responsibility of monitoring air quality. In 1975, the Commission installed and operated four (4) fixed stations with display boards in strategic locations in Metro Manila. In addition, the Commission also maintained two (2) mobile units with analyzers and recorders similar to those in the fixed stations. The fixed and mobile stations were capable of measuring and recording hourly concentrations of carbon monoxide, hydrocarbons, nitrogen oxides, sulfur dioxide, oxidants, and suspended particulates, as well as temperature, humidity, and wind speed and direction.

At present, the fixed air quality monitoring stations in Metro Manila are no longer operational. All of these have been dismantled due to the prohibitive maintenance cost and the difficulty in acquiring replacement parts. As an alternative, the Commission has installed manual samplers, i.e. eight (8) high-volume samplers and six (6) RAC $SO_2$ samplers, in Metro Manila.

The existing ambient air quality monitoring equipment in the country is not sufficient to generate meaningful data. The purchase of additional equipment from

developed countries is not financially feasible at present. There is therefore a need to initiate projects on the design and fabrication of suitable ambient air quality monitoring equipment with a view to reducing monitoring cost and to overcome the problem of maintenance and purchase of essential spare parts.

Initially, this Activity will aim to fabricate the $SO_2$ analyzer and the TSP sampler. As for the other pollutants, i.e. CO, NOx, and HC gases, these will be included in the design and fabrication of the standardized gas sampler. However, quantitative determination of these pollutants will be done on the collected samples through the normal laboratory procedures.

2. ACTIVITY OBJECTIVE

(i) To make ASEAN region self-sufficient in meeting the requirements of effective air quality monitoring through the development of a system suitable to the ASEAN countries situation.

(ii) To develop a framework for the establishment of an air quality monitoring training centre.

3. OUTPUT

(i) Prototype $SO_2$ analyzer and TSP sampler;

(ii) Prototype standardised gas sampling devices;

(iii) Appropriate designs for CO, NOx and HC gas analyzers;

(iv) Training programme on ambient air quality monitoring; and

(v) Framework for the establishment of an air quality monitoring training centre.

4. ACTIVITY COMPONENT

(i) Review of literature, evaluation of operating principles and processes of existing equipment, and consideration of suitable/appropriate design alternatives;

(ii) Collection of basic data on the levels and characteristics of air pollutants, and preparation of design specifications based on collected data;

(iii) Feasibility evaluation of the design and fabrication of $SO_2$, CO, NOx, and HC gas analyzers and TSP samplers;

(iv) Preparation of engineering designs and actual fabrication cost estimates for $SO_2$ analyzer, dust counter, TSP sampler, and standardized air sampler;

(v) Fabrication and calibration of $SO^2$ analyzer and TSP sampler;

(vi) Test run, operation, and application of fabricated equipment;

(vii) Development of training materials and training scheme on air quality monitoring;

(viii) Development of appropriate designs for CO, NOx, and HC gas analyzers; and

(ix) Preparation of a framework for the establishment of an air quality monitoring training center.

5. INPUTS

(a) Government Inputs

The Industrial Technology Development Institute (ITDI) and the National Pollution Control Commission (NPCC) will provide the facilities and staff for all research and development with regard to this Activity. The National Environmental Protection Council (NEPC) will assist in the co-ordination and evaluation of project activities as well as providing linkages with concerned industries and government agencies. The NPCC will also provide sites for testing and operation of the fabricated equipment. Active campaign for the participation of private companies for the supply of essential components or expertise will serve as an additional input, including a possible tie-up for developed monitoring and sampling devices.

(b) UNDP Inputs

Financial lsupport amounting to US$56,400 will be provided by UNDP as follows:

| | |
|---|---|
| Project Personnel and Administrative Support (Eng. Assts. Technical Staff, Clerical Staff etc.) | US$28,344 |
| Equipment | 15,000 |
| Supplies and Materials | 5,000 |
| Training Materials | 5,000 |
| Sundry (Travelling expenses etc.) | 3,056 |
| | US$56,400 |

6. WORK PLAN

As given in Annex 5(a).

7. INSTITUTIONAL FRAMEWORK

The Industrial Technology Development Institute (ITDI) shall be the lead agency for the project as it possesses the capability to conduct research and development work and perform testing and analytical services. The ITDI, formerly known as the National Institute of Science and Technology, is the country's oldest industrial research institution and thus has established extensive research capabilities and a track record of successful research undertakings. One of the Institute's technical divisions, the Environmental division is devoted to research on industrial pollution control, waste utilization and resource recovery, and environmental impact assessment, prediction, and monitoring methodologies. The ITDI will undertake the research component of the project.

Other participating agencies are the National Environmental Protection Council (NEPC) and the National Pollution Control Commission (NPCC). The NEPC is responsible for the development of policy and legislation to ensure the maintenance of a sound environment, and the review and licensing of infrastructure and industrial projects which may have considerable environmental impact. The NPCC, on the other hand, is concerned with the enforcement of environmental pollution regulations, and also performs air and surface water quality monitoring to determine pollutant levels. Both agencies will provide coordinative and technical support to the project.

8. BUDGET

Budget covering UNDP contribution is given in Annex 5(b).

WORK PLAN

Annex 5(a)

COORDINATING COUNTRY : PHILIPPINES

ACTIVITY : DEVELOPMENT OF AMBIENT AIR QUALITY MONITORING EQUIPMENT

| ACTIVITIES | PROJECT MONTH 1988 J F M A M J J A S O N D | 1989 J F M A M J J A S O N D |
|---|---|---|
| (a) Organization of Project Staff | * | |
| (b) Review of Literature, Evaluation of Operating Principles and Processes of Existing Equipment | * * | |
| (c) Collection and Study of Basic Data on the Levels and Characteristics of Air Pollutants in the Country | * * | |
| (d) Selection of Principle of Operation and Establishment of Target Modification for Equipment to be Developed | * * | |
| (e) Engineering Design | | |
| (1) High Volume TSP Sampler | * * * | |
| (2) Standardized Air Sampler | * * * | |
| (3) Automatic $SO_2$ Analyzer | * * * * * * | |
| (4) Continuous Dust Particle Counter | * * * * * * | |
| (f) Fabrication of Prototypes | | |
| (1) High Volume TSP Sampler | * * * | |
| (2) Standardized Air Sampler | * * * * | |
| (3) Automatic $SO_2$ Analyzer | * * * * * * | |
| (4) Continuous Dust Particle Counter | * * * * | |
| (g) Calibration and Test Runs | | |
| (1) High Volume TSP Sampler | * * * | |
| (2) Standardized Air Sampler | * * * | |
| (3) Automatic $SO_2$ Analyzer | * * * | |
| (4) Continuous Dust Particle Counter | * * * | |
| (h) Preparation of Operating Manuals | * * * * * * * * * * * * | |
| (i) Preparation of Training Materials | * * * * * * * * * * * * | |
| (j) Trial Training | * | |
| (k) Concept Design of Other Analyzers | * * * | |
| (l) Preparation of the Framework for the Establishment of an Air Quality Monitoring Training Center | * * | |
| (m) Preparation of Terminal Report | * * | |

## BUDGET COVERING UNDP CONTRIBUTION
## (US DOLLARS)

COORDINATING COUNTRY : PHILIPPINES

ACTIVITY : DEVELOPMENT OF AMBIENT AIR QUALITY MONITORING EQUIPMENT

| | | TOTAL | | 1988 | | 1989 | |
|---|---|---|---|---|---|---|---|
| | | m/m | $ | m/m | $ | m/m | $ |
| 10 | PROJECT PERSONNEL | | | | | | |
| | 17 National Professional | ½ | 500 | ½ | 500 | - | |
| 13 | Administrative Support Personnel | 170 | 27,844 | 85 | 13,922 | 85 | 13,922 |
| 40 | EQUIPMENT | | | | | | |
| | 41 Expendable Equipment/Supplies | | 10,000 | | 8,000 | | 2,000 |
| | 42 Non-Expendable Equipment | | 15,000 | | 15,000 | | |
| 50 | MISCELLANEOUS | | | | | | |
| | 51 Reporting Cost | | 1,500 | | - | | 1,500 |
| | 53 Sundry | | 1,556 | | 1,000 | | 556 |
| Total For Activity | | | 56,400 | | 38,422 | | 17,978 |

ACTIVITY : DEVELOPMENT OF AN ANTI-POLLUTION WOOD WASTE BURNER SYSTEM

1. BACKGROUND AND JUSTIFICATION

The wood-based industries which include sawn log, plywood and veneer and furniture manufacture are important industries for countries in ASEAN. The important contribution to the countries' economy is seen from the fact that earnings from this sector have invariably ranked amongst the toppest export earners. The industries, unfortunately are not efficient in material utilisation. In 1985, Malaysia processed nearly 30.5 million cubic meters of timber. In the course of rendering the wood to the final product, nearly 25% to 40% of the wood is churned out as wastes, depending on the stages of processing involved and the finishes and product forms required.

The wastes so generated take the form of barks, off-cut, saw dust, shaving, planing fines, etc. Only a very small percentage of this wastes is used as fuel for boilers, kiln drying, charcoal making, direct firing by small industries as heat for processing, domestic use, etc. Reutilisation or recycling of these wastes for ancillary products is almost non-existent. While the Department of Environment continues its effort to encourage useful exploitation of the wastes, it is recognized that the 1100 sawmills, 35 veneer and plywood factories and the 900 odd joineries would continue to have occasions to dispose of the wastes through the traditional way they have practised for the past decades. This approach, while not favoured, is necessary owing to various practical restrictions such as low market demands for recycled products, cost of transport of wastes, protection against insect attack, etc.

In this respect, the Department of Environment has prohibited the open burning of wood wastes as the uncontrolled combustion has brought about serious pollution problems. The low heat and incomplete combustion result in haphazard discharge of smoke, fumes, soot and dust. Experience of the past decade shows that the incineration systems adopted range from barely efficient to grossly inadequate. While the University of malaya has developed a cyclonic furnace which proved to be pollution-free, its extremely high cost is a deterrent to its wide application. Other than the lack of a low cost proven burner system, the industries also face the problem that the investigation, development and design cost of a suitable incinerator, even if adopted from existing design, is comparatively high and unaffordable for those who genuinely need it, and it is fair to say that engineering consultants and many of the research institutions have yet to rise to the occasion to render the needed assistance. The reason behind this reluctance can be traced to the time needed to spend if a reasonably good job is to be done and it is clear that the permissible professional charges for a singular job of this nature would far exceed what these small industries could afford.

It is seen from the above that there is urgent need for a low cost yet efficient burner system to be developed, and experience in the field indicate that there exist certain empirical models in the field that if supported by some theoretical inputs, could be expediently utilised. By doing so the time needed for the development of the desirable system would be shorter and the cost incurred could also be reduced. In order for this system to be truly serving its purpose, three or four standard designs should be made available with minumum fees or supplied free to the industries. This should be the case so that anyone who originally could not afford to pay for its design, would now be able to find a suitable system sufficiently close to its capacity. By having such an anti-pollution burner

system easily available for wider application it is anticipated that the proliferation of inefficient wood incinerator would be arrested.

It is believed that this problem of inefficient burner system and its associated pollution problems are not unique to Malaysia, but also common in other ASEAN countries such as Indonesia and Thailand. Therefore the successful development of such a burner system would be beneficial to ASEAN as a whole.

2. ACTIVITY OBJECTIVE

To develop an economically viable anti-pollution burner system for the efficient disposal of wastes generated especially by the small scale wood-based industries in the ASEAN countries.

3. OUTPUT

(i) Three sets of "standard burner system" designs backed up by empirical as well as theoretical considerations. The designs would have been tested and proven suitable for use by most of the small scale wood-based industries without elaborate alteration.

(ii) A manual providing operation guidelines for the proper operation of the burner system. It would contain simple instructions on the necessary maintenance and repairs of the ancillary support equipment to enable mill operator to carry out such tasks on their own.

(iii) A test model of burner system for continual upgrading and improvement of tropical wood burner system.

4. ACTIVITY COMPONENT

This Activity is proposed to be carried out in 4 phases over a period of one year as follows:

Phase 1 - Investigation inclusive of field measurement
Phase 2 - Preliminary designs
Phase 3 - Fabrication and prototype test
Phase 4 - Finalisation of design details and plans

Phase 1 of the Activity would involve the survey of the nature and characteristics of the wastes generated from tropical woods. The work would necessarily include the investigation of some existing incineration systems, e.g. McCashney, Tee-pee, existing blowing and feeding capacities and arrangements, and measurements of air/fuel ratio, gas flow, dust content and other parameters needed for the appropriate design of the burner systems. The consultant engaged should at this stage pay particular attention to the needs for low cost and simplicity in designs, maintenance requirements and availability of indigenous construction materials. This particular phase of the work would require a period of three and a half months to complete.

In Phase 2, the consultant would synthesize the results of his investigations in Phase 1 and prepare his preliminary designs of the burner system. Based on his surveys he is expected to produce at least three sets of burner designs suitable for use by the majority of the wood-based industries in existence. The designs shall be completed with details for wastes storage, materials separation, air and material feeding

mechanism details. On top of this, he is also to prepare a manual on operation guidelines. It is anticipated that the work in this phase would take two and half months to complete.

For Phase 3 of the Activity the Department of Environment would offer the designs so prepared and offer the construction of a model to a potential user. The consultant would carry out occasional site supervision and provide advice to site modification needed. The construction is expected to take up two months of the project time. The consultant would then monitor and type test the performance of his designs in order to fill up whatever gaps that he may encounter in his theoretical works. During this period he is expected to begin work on any modification that may be needed in the sets of plans that he has prepared earlier on. The total time required for this phase is estimated to be four and a half months.

Phase 4 of the activity is in fact a continuing part of Phase 3 where as stated previously, the consultant would have begun reviewing this sets of designs with a view to improve upon them. In this phase he is expected to finalise the designs and produce the final design plans and drawings and operation guidelines for handing over to the authorities that would disseminate the information. The time required for this phase is one and a half months.

5. INPUTS

(a) Government Inputs

The Malaysian Government would provide the necessary assistance to the agency or consultant appointed by way of office space, secretariat support and a senior officer to coordinate the Activity. It will render assistance with regard to communication, transport, data collection, selection of site for the test model and monitoring of the burner performance.

(b) UNDP Inputs

Financial support amounting to US$65,000 will be provided by UNDP as follows:

| | |
|---|---|
| Project Personnel | US$28,600 |
| Equipment/Supplies | 33,400 |
| Reporting Cost | 3,000 |
| | US$65,000 |

6. WORK PLAN

As given in Annex 6(a).

7. INSTITUTIONAL FRAMEWORK

The Department of Environment (DOE), Malaysia would be the implementing agency. The DOE is the governmental agency responsible for the enforcement of the Environmental Quality Act 1974 and the coordination of all activities relevant to the protection and enhancement of the environment. The Department has 50 over senior

professional officers and more than a hundred sub-professional officers. It would be able to assist in pin-pointing the problem areas and the short-coming in existing designs, and the needs for proper disposal and maintenance of conducive living environment. It is therefore well placed to be the lead agency for this Activity. It is anticipated an established research agency such as the Forest Research Institute, Malaysia or a consultant having relevant proven experience in investigation and combustion system design would be assigned to carry out the four phases of the Activity. The Forest Research Institute is a well known institute having numerous experienced staff engaged in wood-based research activities. With its available infrastructure this activity should well fit into its on-going projects.

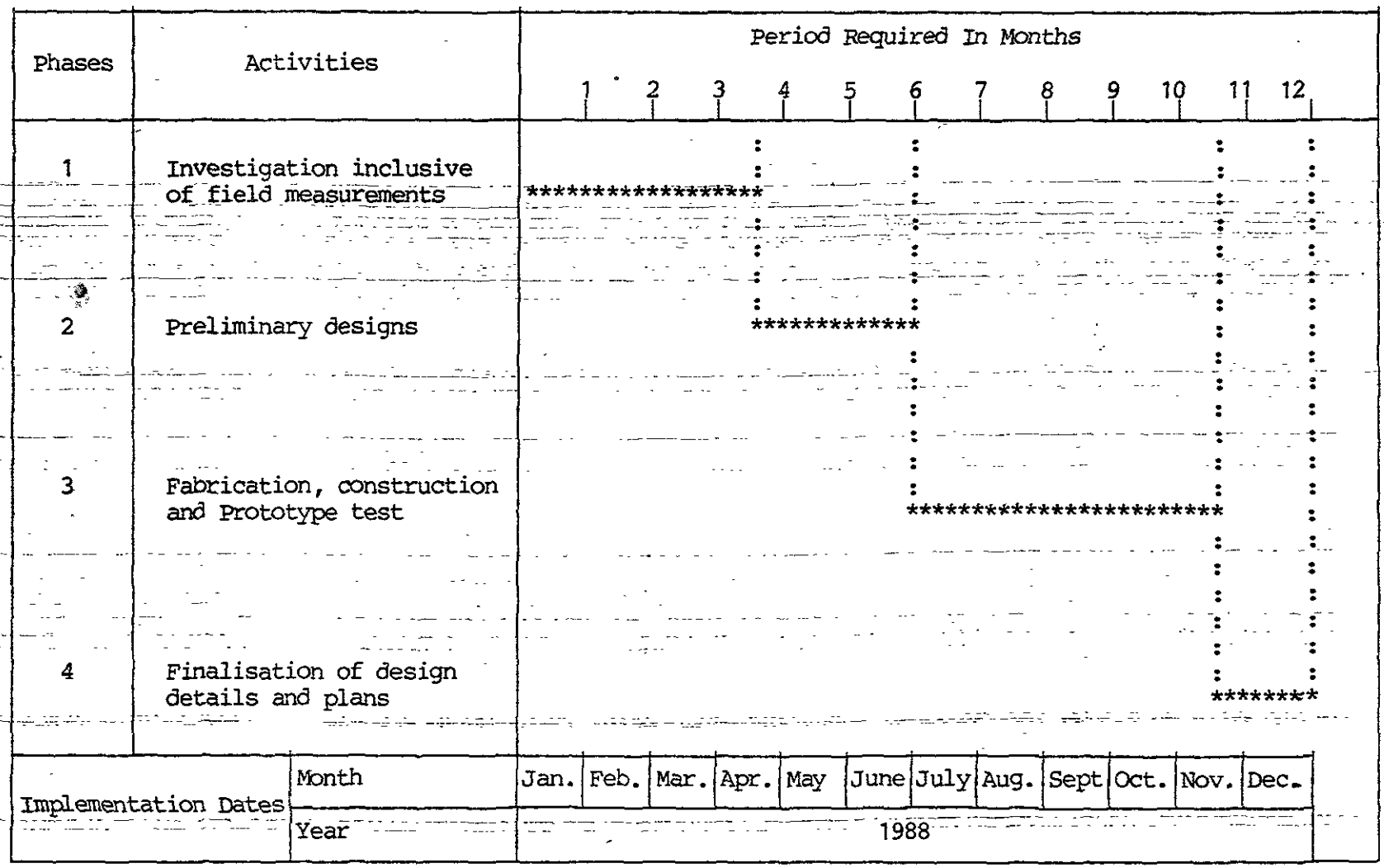
8. BUDGET

Budget covering UNDP contribution is given in Annex 6(b).

# WORK PLAN

COORDINATING COUNTRY : MALAYSIA

ACTIVITY : DEVELOPMENT OF ANTI-POLLUTION WOOD WASTE BURNER SYSTEM



## BUDGET COVERING UNDP CONTRIBUTION
## (US DOLLARS)

COORDINATING COUNTRY : MALAYSIA

ACTIVITY : DEVELOPMENT OF AN ANTI-POLLUTION WOOD WASTE BURNER SYSTEM

| | | TOTAL | | 1988 | |
|---|---|---|---|---|---|
| | | m/m | $ | m/m | $ |
| 10 | PROJECT PERSONNEL | | | | |
| | 17. National Professional | 12 | 24,000 | 12 | 24.000 |
| 13 | Administrative Support Personnel | 6½ | 4,600 | 6½ | 4,600 |
| 40 | EQUIPMENT | | | | |
| | 41 Expendable Equipment/Supplies | | 33,400 | | 33,400 |
| 50 | MISCELLANEOUS | | | | |
| | 51 Reporting Cost | | 3,000 | | 3,000 |
| Total For Activity | | | 65,000 | | 65,000 |

ACTIVITY : INTEGRATED APPROACH TO PIGGERY WASTE POLLUTION CONTROL WITH EMPHASIS ON BIOGAS PRODUCTION

## BACKGROUND AND JUSTIFICATION

Since pork is a major source of meat protein in almost all Thai families, a large number of pig farms are located around the country. For example, in the lower part of the Tha Chin River Basin alone there are approximately 400,000 pigs. The pollution load discharged into the Tha Chin River from the pig farms amount to 22,000 kg. BOD/day with a population equivalent of 1.0 million people. Apart from industrial and domestic wastewaters piggery waste forms one of the major sources of pollution in Thailand and other ASEAN countries. In view of the seriousness of the problem in Thailand a Working Committee has been set up to deal with the problem of pig-waste under the auspices of the National Environment Board.

In most pig farms in the ASEAN region, there are currently no proper systems to control pollution due to lack of cost-effective technology. Environmental problems caused are deterioration of water quality in several of the rivers due to discharge of raw waste, religious sensitivity and odour nuisance.

An effective solution to the problem should take into consideration the whole system of pig farm management from feeding method, water usage to waste handling practice involving low-waste and low cost technology.

2. ACTIVITY OBJECTIVE

To develop a systematic approach to solve the pollution problems of pig farms including the development of an economically viable technology to handle the waste.

3. OUTPUT

(i) Technology for the treatment of waste from small pig farms which is cost-effective and within the economic means of the industry.

(ii) Guidelines for proper farm management.

4. ACTIVITY COMPONENTS

(i) Survey of pig farms including data collection

(ii) Data analysis

(iii) Identification of suitable process, detailed engineering design, construction and operation/ test-run of pilot plant

(iv) Economic evaluation

(v) Preparation of report/manual.

5. INPUTS

(a) Government Inputs

The Thailand Institute of Scientific and Technological Research (TISTR) will provide the facilities and the staff for the Activity. The National Environment Board (NEB) together with TISTR will identify and make available a suitable pig farm for the installation and test-run of the pilot plant proposed.

# WORK PLAN

COORDINATING COUNTRY : THAILAND

ACTIVITY : INTEGRATED APPROACH TO PIGGERY WASTE POLLUTION CONTROL WITH EMPHASIS ON BIOGAS PRODUCTION

| ACTIVITIES | Time, Month | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 1. Project preparation and literature review | = | | | | | | | | | | | | | | | | | | | | | | | |
| 2. Preliminary survey and site selection | | = | | | | | | | | | | | | | | | | | | | | | | |
| 3. Detailed engineering design | | | = | = | | | | | | | | | | | | | | | | | | | | |
| 4. Bidding | | | | | = | = | | | | | | | | | | | | | | | | | | |
| 5. Construction | | | | | | | = | = | = | = | = | = | = | = | | | | | | | | | | |
| 6. Start-up | | | | | | | | | | | | | | | = | | | | | | | | | |
| 7. Test-run analysis and evaluation | | | | | | | | | | | | | | | | = | = | = | = | = | = | | | |
| 8. Progress report | | | | = | | | | = | | | | = | | | | = | | | | = | | | | |
| 9. Final report preparation | | | | | | | | | | | | | | | | | | | | | | = | = | = |

(b) UNDP Inputs

Financial support amounting to US$44,259 will be provided by UNDP as follows:

| | |
|---|---|
| Support Personnel 12 m/m Technicians | US$ 1,412 |
| Survey | 784 |
| Design and Construction of Pilot Plant | 33,725 |
| Operating Cost | 1,961 |
| Reporting Cost | 3,000 |
| Sundry | 3,377 |
| | US44,259 |

6. WORK PLAN

As given in Annex 7(a).

7. INSTITUTIONAL FRAMEWORK

The National Environment Board (NEB) in cooperation with Thailand Institute of Scientific and Technological Research (TISTR) will be the Lead Agency Coordinator. TISTR is one of the most experienced Research Institute and has been involved in R and D work on anti-pollution control technology since 1976.

8. BUDGET

Budget covering UNDP contribution is given in Annex 7(b).

## BUDGET COVERING UNDP CONTRIBUTION
## (US DOLLARS)

COORDINATING COUNTRY : THAILAND

ACTIVITY : INTEGRATED APPROACH TO PIGGERY WASTE POLLUTION CONTROL WITH EMPHASIS ON BIOGAS PRODUCTION

| | TOTAL | | 1988 | | 1989 | |
|---|---|---|---|---|---|---|
| | m/m | $ | m/m | $ | m/m | $ |
| 13 Support Personnel | 12 | 1,412 | 6 | 706 | 6 | 706 |
| 40 EQUIPMENT | | | | | | |
| 41 Expendable Equipment/Supplies | | 33,725 | | 28,100 | | 5,625 |
| 50 MISCELLANEOUS | | | | | | |
| 51 Reporting Cost | | 3,000 | | - | | 3,000 |
| 53 Sundry | | 6,122 | | 3,500 | | 2,622 |
| Total For Activity | | 44,259 | | 32,306 | | 11,953 |

ACTIVITY : POLLUTION CONTROL MANAGEMENT
FOR TAPIOCA - STARCH WASTEWATER

## I. BACKGROUND AND JUSTIFICATION

Thailand is world's largest exporter of tapioca. Annually Thailand produces about 20 million tons of tapioca tubers (roots). The tubers are processed to produce chips, pellets and starch powder. The production of tapioca starch is a water consuming process and therefore a large volume of wastewater is generated with a BOD value of 6000 mg/l. A medium size tapioca starch factory discharges effluent of about 2000 $m^3/d$. This, being an organic waste, has serious environmental consequences on the water quality of the rivers. Malaysia has also been experiencing serious water pollution problems due to tapioca starch wastewater.

The most popular treatment technology that has been developed so far is the ponding system (oxidation ponds). But there has so far been no proper assessment of performance of the existing ponding system as well as there is a lack of proper design criteria for use by the ASEAN countries. Hence there is a need for a performance and economic evaluation of the existing systems as well as a study of the ongoing research and development projects on tapioca starch wastewater treatment systems and formulate recommendations for general upgrading of ponding system including appropriate design criteria and other possible technology for treatment and utilisation.

## ACTIVITY OBJECTIVE

To upgrade pollution control measures including treatment systems, formulate appropriate design criteria for ponding system and recommend other technology for treatment and utilisation.

3. OUTPUT

(i) Design criteria for ponding system

(ii) Guidelines for pollution control management in the tapioca starch industry

(iii) Recommendations for further research with respect to other possible treatment systems and utilisation of waste.

4. ACTIVITY COMPONENT

(i) Literature review concerning treatment methods

(ii) Survey evaluation and assessment of the existing tapioca industry and waste treatment facilities

(iii) Formulation of recommendations and guidelines

(iv) Preparation of report.

5. INPUTS

(a) Government Inputs

The Thailand Institute of Scientific and Technological Research (TISTR) will provide the staff and facilities for the Activity. The National Environment Board will serve as the coordinator.

(b) UNDP Inputs

Financial support amounting to US$5,741 will be provided by UNDP as follows:

| | |
|---|---|
| Chemicals for analysis | US$1,375 |
| Survey expenses | 1,176 |
| Glassware | 195 |
| Stationery and miscellaneous items | 195 |
| Sundry | 1,300 |
| Reporting Cost | 1,500 |
| | US$5,741 |

6. WORK PLAN

As given in Annex 8(a).

7. INSTITUTIONAL FRAMEWORK

This project will be implemented by TISTR with NEB as the coordinator.

8. BUDGET

The budget covering UNDP contribution is given in Annex 8(b).

# WORK PLAN

COORDINATING COUNTRY : THAILAND

ACTIVITY : POLLUTION CONTROL MANAGEMENT FOR TAPIOCA STARCH WATER

| ACTIVITIES | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1. Project Preparation/ Literature Review | ═══ | ═══ | | | | | | | | | | |
| 2. Survey and Sampling | | | ═══ | | ═══ | | ═══ | | | | | |
| 3. Evaluation and Assessment | | | | | | | ═══ | ═══ | | | | |
| 4. Progress report and report writing (Draft) | | | | | | ═══ | | | ═══ | ═══ | | |
| 5. Final Report Preparation | | | | | | | | | | | ═══ | ═══ |

## BUDGET COVERING UNDP CONTRIBUTION
(US DOLLARS)

COORDINATING COUNTRY : THAILAND

ACTIVITY : POLLUTION CONTROL MANAGEMENT FOR TAPIOCA STARCH WASTEWATER

| | TOTAL $ | 1988 $ |
|---|---|---|
| 40 EQUIPMENT | | |
| 41 Expendable Equipment/Supplies | 1,570 | 1,570 |
| 42 Non-Expendable Equipment | 195 | 195 |
| 50 MISCELLANEOUS | | |
| 51 Reporting Cost | 1,500 | 1,500 |
| 52 Sundry | 2,476 | 2,476 |
| Total For Activity | 5,741 | 5,741 |

ACTIVITY : WATER HYACINTH HARVESTING, MANAGEMENT AND UTILISATION

1. BACKGROUND AND JUSTIFICATION

In Thailand, profuse growth of water hyacinth in rivers, canals and ponds has caused considerable environmental problems. Most significant among them are navigational problems, clogging of water pumps used for irrigation and waterworks and degradation of the quality of potable water resources. Elimination of water hyacinth has become an enormous problem in Thailand, Philippines and Indonesia.

Todate there has not been available any satisfactory method of harvesting and utilisation or disposal of water hyacinth in the ASEAN region. Therefore there is an urgent need to undertake studies on commercial utilisation of water hyacinth as well as development of proper harvesting methods.

2. ACTIVITY OBJECTIVE

(i) To control the quantity of water hyacinth in watercourses through the development of a practical harvesting system.

(ii) To make water hyacinth as a resource to be utilised as fertiliser and energy source on a commercial scale.

3. OUTPUT

(i) Appropriate technology for harvesting of water hyacinth.

(ii) Fertiliser and fuel.

4. ACTIVITY COMPONENT

(i) Review of barge and mechanical part modification literature and characteristics of water hyacinth literature.

(ii) Design, installation and field-tests of a pilot scale barge model.

(iii) Evaluation of performance data and design criteria for scale-up and economic analysis.

(iv) Utilisation of water hyacinth as fertiliser and fuel.

(v) Preparation of reports.

5. INPUTS

(a) Government Inputs

King Mongkut Institution of Technology Ladkabang and the Asian Institute of Technology will provide all the staff and facilities for this Activity and the National Environment Board of Thailand will act as the coordinator.

6. (b) UNDP Inputs

Financial support amounting to US$50,000 will be propvided by UNDP as follows:

| | |
|---|---|
| Support personnel 36 m/m | US$3,725 |
| Sub-contract | 30.000 |
| Barge with engine | 3,137 |
| Chopping set with engine | 3,922 |
| Water hyacinth collector | 1,569 |
| Press roller | 1,569 |
| Hydraulic package | 1,961 |
| Survey expenses | 588 |
| Operation expenses | 784 |
| Sundry | 1,245 |
| Reporting cost | 1,500 |
| | US$50,000 |

6. WORK PLAN

As in Annex 9(a).

INSTITUTIONAL FRAMEWORK

The part of the Activity on harvesting and management will be implemented by King Mongkut Institute of Technology supervised by the National Environment Board of Thailand. The part of the Activity on utilisation of hyacinth as fertiliser and fuel will be sub-contracted to the Asian Institute of Technology for implementation. The King Mongkut Institute of Technology will provide a multidisciplinary team consisting of mechanical, agricultural and industrial engineers for the Activity. The Asian Institute of Technology is an autonomous, non-profit making, international and educational post-graduate technological institute located near Bangkok providing education on engineering, science and allied field. It has behind it more than 28 years of experience in environmental R&D work.

BUDGET

The budget covering UNDP contribution is given in Annex 9(b).

# WORK PLAN

COORDINATING COUNTRY : THAILAND

ACTIVITY : WATER HYACINTH HARVESTING, MANAGEMENT AND UTILISATION

| ACTIVITIES | Month | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 1. Project preparation, Literature review and information collecting | ═══ | ═══ | | | | | | | | | | | | | | | | |
| 2. Preliminary survey and site selection | | | ═══ | | | | | | | | | | | | | | | |
| 3. Detailed engineering design | | | | ═══ | ═══ | ═══ | | | | | | | | | | | | |
| 4. Equipment construction and assembly | | | | | | | ═══ | ═══ | ═══ | ═══ | ═══ | ═══ | | | | | | |
| 5. Start-up and test-run of the barge | | | | | | | | | | | | | ═══ | ═══ | ═══ | | | |
| 6. Efficiency improvement | | | | | | | | | | | | | | | ═══ | ═══ | | |
| 7. Progress report | | | | | ═══ | | | | | ═══ | | | | | ═══ | | | |
| 8. Final report preparation | | | | | | | | | | | | | | | | ═══ | ═══ | ═══ |

Annex 9(a)

| Activities | Months | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| 1. Project Preparation | | | | | | | | | |
| a. Data collection and Literature review | xxx | | | | | | | | |
| b. Preparation of experimental units and chemicals | | xxx | | | | | | | |
| 2. Water hyacinth as an Energy Source | | | | | | | | | |
| a. Experiments on Briquette making | | | xxx | xxx | xxxx | xxxx | xxxx | xx | |
| b. Data analysis | | | | | | | | xx | |
| 3. Water hyacinth as fertilizer | | | | | | | | | |
| a. Composting | | | xxx | xxx | xxxx | xxxx | xxxx | xx | |
| b. Properties analysis | | | | xxx | xxxx | xxxx | xxxx | xxxx | |
| c. Data analysis | | | | | | | | xxxx | |
| 4. Progress report | | | xx | | | xx | | | |
| 5. Final Report | | | | | | | | | xxxx |

## Project Budget Covering UNDP Contribution
(In U.S. Dollars)

Region: ASEAN

Project Number: RAS/86/111/ D/01/31

Project Title: Anti-Pollution Technologies for Urban and Rural Areas in the ASEAN Region

| | Total | | 1987 | | 1988 | | 1989 | |
|---|---|---|---|---|---|---|---|---|
| | m/m | $ | m/m | $ | m/m | $ | m/m | $ |
| 10. Project Personnel | | | | | | | | |
| 11.61 Consultants | 1.5 | 19,000 | 1.0 | 13,460 | 0.5 | 5,540 | | |
| 19. Component Total | 1.5 | 19,000 | 1.0 | 13,460 | 0.5 | 5,540 | | |
| 20. SUB-CONTRACTS | | | | | | | | |
| 21. Air and water pollution (Singapore) | 24 | 48,500 | | | 12 | 24,250 | 12 | 24,250 |
| 22. Noise control (Singapore) | | 58,000 | | | | 58,000 | | |
| 23. Industrial wastes and Air Quality (Philippines) | | 150,000 | | | | 109,722 | | 40,278 |
| 24. Wood-waste Burner (Malaysia) | | 65,000 | | | | 65,000 | | |
| 25. Piggery waste & Tapioca starch wastewater treatment (Thailand) | | 50,000 | | | | 38,047 | | 11,953 |
| 26. Water Hyacinth (Singapore) | | 50,000 | | | | 36,390 | | 13,610 |
| 29. Component Total | | 421,500 | | | | 331,409 | | 90,091 |
| 50. MISCELLANEOUS | | 1,000 | | | | 500 | | 500 |
| 59. Component Total | | 1,000 | | | | 500 | | 500 |
| 99. GRAND TOTAL | | 441,500 | | 13,460 | | 337,449 | | 90,591 |

## Project Budget Covering UNDP Contribution
(In U.S. Dollars)

Region: ASEAN

Project Number: RAS/86/111/ D/01/31

Project Title: Anti-Pollution Technologies for Urban and Rural Areas in the ASEAN Region

| | Total | | 1987 | | 1988 | | 1989 | |
|---|---|---|---|---|---|---|---|---|
| | m/m | $ | m/m | $ | m/m | $ | m/m | $ |
| 10. Project Personnel | | | | | | | | |
| 11.61 Consultants | 1.5 | 19,000 | 1.0 | 13,460 | 0.5 | 5,540 | | |
| 19. Component Total | 1.5 | 19,000 | 1.0 | 13,460 | 0.5 | 5,540 | | |
| 20. SUB-CONTRACTS | | | | | | | | |
| 21. Air and water pollution (Singapore) | 24 | 48,500 | | | 12 | 24,250 | 12 | 24,250 |
| 22. Noise control (Singapore) | | 58,000 | | | | 58,000 | | |
| 23. Industrial wastes and Air Quality (Philippines) | | 150,000 | | | | 109,722 | | 40,278 |
| 24. Wood-waste Burner (Malaysia) | | 65,000 | | | | 65,000 | | |
| 25. Piggery waste & Tapioca starch wastewater treatment (Thailand) | | 50,000 | | | | 38,047 | | 11,953 |
| 26. Water Hyacinth (Singapore) | | 50,000 | | | | 36,390 | | 13,610 |
| 29. Component Total | | 421,500 | | | | 331,409 | | 90,091 |
| 50. MISCELLANEOUS | | 1,000 | | | | 500 | | 500 |
| 59. Component Total | | 1,000 | | | | 500 | | 500 |
| 99. GRAND TOTAL | | 441,500 | | 13,460 | | 337,449 | | 90,591 |