OCCASION

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

DISCLAIMER

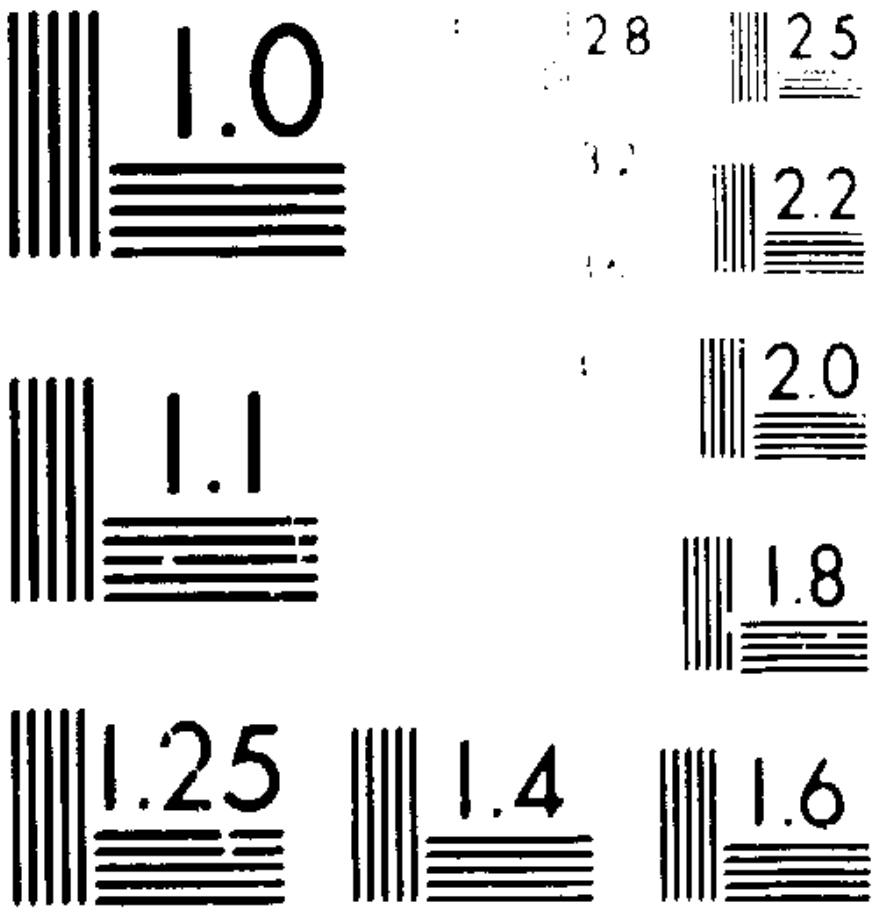
FAIR USE POLICY

CONTACT

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

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

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


2.8
2.5
1.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

09543

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

INDUSTRIAL DEVELOPMENT AND THE ENVIRONMENT

Prepared by the Secretariat of UNIDO
Vienna, 1972

FOREWORD

The current concern with improving and/or maintaining environmental quality has led to new assessments of the role and responsibilities of the industrial sector. This paper proposes an industrially oriented approach to environmental matters, with special regard to conditions in the developing countries. Emphasis is given to the activities of the United Nations Industrial Development Organization (UNIDO) in providing technical assistance in handling such matters.

The initial draft of this report was prepared for UNIDO by the International Union for Conservation of Nature and Natural Resources in Morges, Switzerland. The draft report was circulated to a number of specialists in the UN system of organizations, governments and private consultants for their review and comments. Following the review, UNIDO's Industrial Technology Division met with a select group of consultants at its headquarters and prepared this report which comprises the results of these combined activities.

The initial purpose of the report was to provide guidance for UNIDO in formulating its technical assistance programmes. However, it is felt that the report provides some useful insights into the relationship between industry and the environment that merit wider distribution. Accordingly, it is being submitted by UNIDO to the United Nations Conference on the Human Environment, to be held in Stockholm in June 1972, as a part of UNIDO's contribution to it.

TABLE OF CONTENTS

INTRODUCTION

1. The concern with environmental issues betrays a philosophical and pragmatic shift in mankind's thinking. An ancient dualistic habit of contrasting man and environment, finite and infinite, closed spaces and open systems is giving way to a new approach in scientific thinking, to a new environmental synthesis in which fragmented knowledge about the environment and society is being replaced by a concept of the environment as a system in process and change.

2. It is generally accepted that there is a direct relationship between industrial development and the environment, and this crucial and vital relationship has recently been attracting increased attention. While the degree of impact of industrial development on the quality of the environment differs from country to country, usually depending upon their stage of development, the desire to maintain an environmentally sound industrial development is rapidly becoming of universal concern. Environmental issues will therefore come to exercise a growing influence on industrial development policy.

3. The legitimate question is being raised, "How to promote an economically and socially advantageous industrial development programme and at the same time protect the natural environment and develop a desirable human environment?" Countries at the threshold of economic development do not want to forego industrialization; however, they will want to avoid disruptions that constitute serious hazards to human health, depletion of natural resources and destruction of their patrimony.

4. The preoccupation of the developing countries is not merely the "quality of life" but life itself, which is often endangered by natural disasters, malnutrition, shortage of water, lack of sanitation, poor housing and, generally, low standards of living.

In the low-income countries these problems are equal to or greater than those of industrial pollution and waste in an affluent society. The actual problem of poverty and the potential problem of industrial threats to environment affect the greater part of mankind. The developing countries clearly want to avoid the mistakes that have characterized the patterns of development of already industrialized societies.

5. Industrialization is often one of the major solutions to the problems of poverty and underdevelopment. Industrial development can indeed become a major solution to these problems with the incorporation of environmental criteria and goals. In this context, there need not be a major conflict between development and maintaining a desirable human environment. Each country will have to decide, in the light of its own situation and development strategy, the policy it wishes to follow. Industrialization generally results in the release of pollutants and wastes, and thus reacts on the environment in many ways. However, with appropriate planning, management and control, the detrimental impact upon the environment can be minimized. The growth of the entire infrastructure of transport and communications needed to support industrialization may also affect the environment. Lacking a clear national policy, industrial development without environmental considerations can aggravate the social and political tensions that prevail in many societies today.

6. Environmental instability has become the problem of industrial civilization. Air, water, earth, light, vegetation, animals and natural resources are all exploited for human welfare. All aspects of nature are continuously being transformed by industrial civilization, and each new balance is modified every day. The dynamics of environment are the dynamics of the society itself. The responsive structuring of the new environemnt in a populated world is one of the main activities of industry; consequently industry is becoming one

of the major environmental managers.

7. Environmental considerations by industry will lead to technological assessment [1] with environmental parameters. Industry will increasingly respond to various needs; there will be increased scientific understanding of environmental disruptions caused by the consequences of technological diffusion; there will be greater appreciation among technologists and political leaders of the possibilities of applying technology to the partial alleviation and solution of environmental deterioration; and scientific ways of anticipating technical and social developments will emerge.

8. It is generally agreed that five major undesirable side effects accompany industrial development. [2] These are:

(a) Resource deterioration: the deterioration, for example, of mineral, soil or forest resources;

(b) Biological pollution: the pollution represented by agents of human disease, and by animal and plant pests;

(c) Chemical pollution: arising out of air pollutants, industrial effluents, pesticides, metal. and detergent components and similar agents;

(d) Physical disruption: as reflected, for example, by thermal pollution, silting and noise; and

(e) Social disruption: of which congestion and loss of a sense of community are examples.

---

[1] Technological assessment has been defined to comprise "the socio-technical knowledge that discloses the benefits and risks to society emanating from alternative courses in the development of scientific and technological opportunities". (United States National Academy of Engineering.)

[2] See Development and Environment, a report submitted by a panel of experts convened by the Secretary-General of the United Nations Conference on the Human Environment, Founex, Switzerland, 4-12 June, 1971.

9. The industrializing nations have the advantage of being able to learn from the experience of the developed nations. They can practice turning the wastes of the industrial society into benefits for their people. Environmental deterioration can be caused together by industry, agriculture and the community. In many instances, the agricultural and domestic contribution to the reduction of environmental quality is equal to or greater than that of industry. All of these are interrelated. In the absence of planning and control, industrial communities may grow into unwieldy and inefficient aggregates; however, through a proper choice of community awareness, appropriate planning, technology and plant design, industrializing societies can minimize the total economic costs.

10. One of the more tangible relationships presently recognizable between industrial development and the environment is emerging in the owners and managers of industrial enterprises; they are beginning to understand the overall nature and potential risks of the processes and products that they control. If this relationship is not understood, it is difficult to give proper terms of reference to the individual design and process technologists who must establish parameters that will ensure that wastes and the risk of disposing of them will be reduced to an absolute minimum. Supporting techniques of treating residual materials and rendering them harmless then becomes much simpler.

11. The creation of a beneficial environment for man is more than pollution control; [3] it also involves planning and management.

---

[3] "Pollution is the presence at large of substances or energy patterns which have been involuntarily produced by man or, though voluntarily produced, have outlived their purpose, have escaped by accident, or have unforeseen effects in quantities which harm or may harm his health, or do offend him". (Lord Kernet, then Minister of Housing and Local Government, in the Government of the United Kingdom, in 1969.)

In fact, in the industrializing countries, the appropriate planning and management to prevent environmental degradation from reaching some specified limits may be of primary importance, whereas in the already industrialized countries and regions, control may be of primary importance. The interdependence between industrial development, community and environment requires that industry and the public co-operate to help establish goals, policies, standards and programmes.

12. The scope and context of this paper aims at demonstrating the role of industrial development in environmental planning, management and control. It does not purport to produce final answers but hopes briefly to summarize the practical techniques and methodology in accordance with the best available knowledge and experience.

CHAPTER I

CONSEQUENCES OF INDUSTRIAL PROCESSES AND/OR PRODUCTS UPON THE ENVIRONMENT

Background

13. For all countries, some problems such as natural catastrophes have been of an environmental nature, while others have arisen because of changing national and community factors such as increasing consumer affluence. In this context, not all environmental problems are consequences of industrial processes and products. Furthermore, such processes and products can also contribute to environmental enhancement.

14. Industrial development plays a key role in the comprehensive and integral development process; it affects all countries from the twenty-five least-developed ones identified by the United Nations Committee for Development Planning,[4/] to those most advanced in development. Each country, whatever its stage of development, has an individual situation, both in terms of its internal development and its international development potential. This individual situation will need to be determined and specified in each case, especially since internal and international development are becoming increasingly interdependent. A strategy of development on the national level is a prerequisite for regional and international interrelatedness. Therefore, the over-all consequences of industrial processes and/or products upon the natural environment and subsequently on the human environment, must be ascertained in each individual situation.

15. Detailed knowledge of the consequences of the numerous industrial processes and products helps in formulating and charting an industrial development strategy attuned to environmental consideration. Pollutants and nuisances from various sources differ in their effect upon the environment, especially with regard to the media that receive them, namely; the air, water and soil.

4/ The United Nations criteria for determining stage of development are based on gross domestic product per capita, on a manufacturing share and literacy rate.

16. This chapter outlines some of the more significant general approaches for acquiring and analyzing detailed information with respect to the environmental consequences of industrial products and processes.

Facilities discharging wastes (pollutants)

17. In general in addition to their products, industrial processes produce wastes, and these are discharged to the environment, that is, into the air, water and soil. While the products are used for the benefit of mankind in their use they may also produce further wastes or pollutants; (the internal combustion engine is a classic example). Furthermore, products are seldom entirely consumed and the remains of these products are generally disposed of in the environment. Many such wastes contain harmful substances and become threats to mankind. Other discharged substances are only nuisances until a certain aggregate level is reached, at which point they also become dangerous.

18. At the present time, knowledge of industrial pollutants is incomplete. Measurement of hazards has generally been done over short-term periods. Too little is known about the non-intensive but prolonged effects, which has often led to inexact statements concerning the over-all impact of processes and products. Nevertheless, there are acute or chronic conditions that call for immediate action and already enough is known so that positive action can be taken.

19. Many industrial processes are known to discharge toxic or otherwise harmful substances such as mercury, cadmium, lead, organophosphorous compounds, chromium and arsenic. Annex I gives some pertinent examples from the most common industrial processes. It should be noted that many of these processes are now being introduced into the developing countries, primarily on the basis of the "minimum adequate" concept. In accordance with this concept, as a rule, no provision is made at the design stage for pollution-abatement facilities. However with proper planning, management and control, they need not pose a threat to the welfare of these countries.

20. Annex 2 lists some of the most important known waste products that act as pollutants and their effects upon the environment.

21. One of the most common ways of acquiring information about the consequences of industrial processes and products is simply to compile lists similar to annexes 1 and 2; every country or state could prepare such a list. However, there are many problems associated with such listings, among them the appropriate definition of pollutants, the identification of all sources of each pollutant, the magnitude of the problem created by each pollutant and the correct interpretation of the compiled information. The advantages of such a compilation are that general classes of pollutants could be illustrated, the primary man-made source identified and the general environmental effects stated. It is emphasized that no such listing can be definitive at this stage of research and knowledge; it would only be indicative of the order of magnitude of the problems facing a country and of the great responsibility that rests with industry as a major environmental manager.

22. Industry's recognition of the need for constant reappraisal of process and product technology is increasing. Much additional information is needed to expand the knowledge of the public, political leaders and industrial managements concerning the more important pollutants and their interactions with other industrial products and waste. A detailed listing of installations that discharge wastes and pollutants into the environment is only the initial step towards expanding the necessary knowledge.

Classification scheme

23. The classification of the environmental consequences of industrial processes and products can only be undertaken in relation to specific purposes. Various classification schemes can be useful aids in helping to understand and measure the impact on environmental enhancement or environmental deterioration. These consequences may be viewed in terms of a classification scheme oriented toward national or regional development goals.

24. What are the real long- and short-term social and economic requirements with respect to the environment? The setting of national or regional goals normally takes place within a long-term framework but is normally

implemented by short-term activities and programmes. Thus, classification schemes for determining the impact of industrial development on the environment can best be understood in the following terms:

(a) Time (short, medium or long term);
(b) Space (inside or outside the plant, local and concentrated or regional and dispersed, multinational and global);
(c) Process (primary, intermediate or final);
(d) Product design (technical parameters);
(e) Products (primary, intermediate or consumer goods);
(f) Intensity (function and quantity of the product).

25. The environment can be damaged by both the collective effect of population behaviour or the individual effect of concentrated industry. By virtue of the magnitude of the industrial system, cumulative time and space effects are beginning to play an increasingly critical role in the short-term measured effects. However, control and abatement of specific pollutants and hazards are significantly different in alternative situations. The immediate direct effects upon air, water and soil may be observed, but the indirect effects related to the concentration of population and industry over the long-term is difficult to ascertain. Furthermore, the critical values of individual hazards generally differ from their cumulative effects.

26. With the use of an appropriate classification framework, the impact of industrial processes and products upon the biosphere, the ecosystem and human environment (especially including human settlements as altered by industrialization), can be better observed and understood. Since the self-regulating capacity (including self-cleaning) of environment at its various levels decreases with the increase in industrialization unless some appropriate type of action is undertaken, an appropriate classification framework would allow for a distinction between the need for control and abatement technologies and their potential social and economic cost and value.

27. Once the general framework of a classification scheme has been established, standards for design, processes and products which generally constitute basic exercises in industrial responsibility, may be developed that can be environmentally oriented.

28. Within the general formulation, an environmentally oriented classification scheme may be developed that is consistent with individual, national or regional goals and that can serve as a basis for further evaluation of the present and potential consequences of industrial products and processes upon the environment.

Material balance sheet

29. Some pollution results from specific technologies, whereas some follows from a failure to apply appropriate or additional technology. Often by the application of such technology, the present pollutants can be converted into additional useful products.

30. The industrial production process is entering a new phase. Scientific research is enabling industry to obtain a multiplicity of products from the same raw materials. When previously the industrial process turned "nature" into "product" plus "waste", improved technology has expanded the products portion and has begun to diminish and even eliminate the production of waste. With the approaching scarcity of some raw materials and the increased capacity to synthesize others, this trend will accelerate. Thus, what is presently called a waste or pollutant is often an unutilized resource. In the foreseeable future, many industrial production processes could conceivably consist solely of various inputs and various products. For such processes, all former wastes could be turned into benefits.

31. In the above context, another way of analyzing the consequences of industrial processes and products is through the use of a material balance sheet. The input and output of materials lends itself to a schematic view of the inflow. The complete flow required in a given production process elucidates the qualitative and quantitative degree to which a specific industry enhances and/or disturbs the environment. Figure I of annex 3 is a schematic depiction of materials flow.

32. Material balance sheets may be constructed at various levels of sophistication: by industry category (see annex 3, figure 2), by individual product (see annex 3, figures 3, 4 and 5), and by individual plants utilizing a specific process and producing specific product(s). The choice of the level at which to construct and produce depends on the purpose to be served; a lesser degree of sophistication may be required than at the individual plant level where additional technology and facilities will need to be introduced either to control or to utilize the waste outputs. In fact, at the individual plant level, only specialists in the specific processes can construct, analyse and effectively utilize the material balance sheet, since each production unit best knows its own inputs and outputs and can assess the yields to be optimized.

33. Inspection of the figures of annex 3 reveals that production residues can constitute raw materials for various processes. At present, however, most residues are wasted. For example, although the demand for forest products, particularly pulp and paper, is rapidly increasing, the various processing stages are still quite inefficient, resulting in enormous tonnages of unrecovered organic wastes. Similarly, residual wastes from the processing of food products tend to be high in organic matter which for instance, reduce dissolved oxygen in rivers and streams. A great deal of research in the re-use of waste is yet needed, and the dissemination of such information could well become an enormous undertaking. The developing countries, particularly, should take advantage of the latest information on material balances in specific production processes. Indeed, forward-looking countries will insist on the materials balance being part of any pre-investment and feasibility studies.

Environmental criteria

34. As a result of the increased activity in all sectors of the economy, increasing attention is being focused on the establishment of environmental criteria. It has aleady been pointed out that there is an environmental interaction between the community, agricultural and industrial development and other aspects of the quality of life.

The specifications for environmental criteria are the judgement of a national authority against some set of socioeconomic criteria.

35. Once a national authority establishes environmental criteria, the impact of industrial processes and products may be judged according to them. It is emphasized, however, that industry itself, or its representatives, should participate in the establishment of these criteria. Industrial participation in their establishment has many advantages, among them being industry's increased awareness of its vast responsibility, the bringing forth of its resources to bear on the problems, and the incorporation of its viewpoints, thereby ensuring its co-operation.

36. International organizations can provide assistance upon request in working out environmental criteria at the national level. Thus, initially environmental criteria will differ from country to country, responding to local needs. However, international agreements are likely to produce minimal regional environmental quality standards. The higher the agreed-upon international threshold of pollution, the less likely will advanced countries be to export their polluting industries. Also, developing countries will want to avoid the future costs of environmental restoration. The pressure to remove industries from countries with very sophisticated standards and tight specifications to less-demanding developing countries is mounting. This development offers good opportunity for industrialization, but the developing countries should take sufficient precautions against accepting highly polluting industries.

37. If environmental criteria are not worked out and enforced, a slowing of industrialization and the setting up of barriers to trade may result. International harmonization and co-ordination of environmental criteria are in the interest of the developing countries. Quality standards to ensure human well-being should be established everywhere. These standards can be enforced by appropriate means such as charges, taxes and subsidies. Since environmental quality standards in advanced countries are relatively higher than those of the

developing countries, their absorptive capacity, as regards pollution-causing industries, is lower than that of the developing countries, which thus have a competitive advantage as regards the location of new industries. Nevertheless, the developing countries will have to incorporate environmental criteria into their industrial plans if they are to encourage industrial development without jeopardizing their not-yet-polluted environments.

Economic aspects: total costs and total benefits

38. Increased output, or economic growth, has often been regarded as an end in itself, thereby emphasizing so-called economic efficiency as the primary objective of mankind. This preoccupation with increased output (production), which has enhanced well-being on an increasingly wide scale and will continue to do so in the foreseeable future, especially in the developing countries, inevitably has adverse effects on both the natural and human environments.

39. Growth of output through industrialization and the maintenance of a desirable environment need not be viewed as conflicting goals or objectives; the resolution of potential conflicts can occur through proper planning, management and control, giving full consideration in the decision-making process, to the total economic consequences. Since the primary goal of development should be to enhance the general well-being of the entire population, full consideration must be given to the total economic and social aspects of any policy, programme or activity.

40. As noted above, industrial development is often one of the major solutions to the problems of poverty and underdevelopment. On the other hand, industrial development, either directly or indirectly, affects the environment adversely. The total consequences of industrial products and processes upon the environment can only be ascertained by giving full consideration to their total costs and total benefits.

41. Traditional benefit-cost analysis was formulated with the assumption of economic efficiency as the only goal or objective; no other objective was given explicit consideration in the decision-making process. Consequently, traditional benefit-cost analyses are insufficient, since they fail to incorporate other criteria and goals; in this context they are often inadequate and misleading.

42. Since traditional benefit-cost analyses have been recognized as being insufficient for incorporating environmental and other objectives, much attention has been given to these aspects and new conceptual thinking is emerging. Therefore, it is becoming increasingly easier to give full economic consideration to all aspects of industrial development, explicitly specifying the total benefits and total costs.

CHAPTER II

RANGE OF AVAILABLE APPROACHES TO THE MANAGEMENT OF THE ENVIRONMENT BY INDUSTRY

43. Prior sections of this report have discussed the interdependence of industrial development and the environment and also the consequences of industrial processes and products in terms of classification schemes, material balance sheets, environmental criteria, and total costs and total benefits. Within this framework, the present chapter discusses the range of available solutions. These solutions can be seen as developing from the simple to the extremely complex. No attempt is made to be exhaustive nor to illustrate the relative difficulties in their application, but only to illustrate that there is a range of solutions presently available to policy-makers and to industry itself. Furthermore, the urgency of the problems significantly affects the search for solutions.

Degrees of urgency for prevention and control

44. Many countries are not yet faced with a serious environmental problem in which industrial development plays a specific role. Such countries still have a tremendous absorption capacity before reaching critical environmental parameters. In such cases the restoration of a deteriorated environment is not a national problem. Such countries may continue to integrate industrial development into their national development, hoping thereby to improve the quality of life; however, even in this case, it is emphasized that prevention is preferable to later corrective action. Policy-makers will find prevention of environmental deterioration less costly even in the short-term than restoration; in fact, preventive measures may not sigificantly increase costs if appropriate policies and planning are undertaken. The protection of present conditions must be considered in planning for future eventualities. In this situation, while there is no urgency for corrective measures, there may be an urgency for preventive measures.

45. Other countries are experiencing the dynamics of an expanding economy and technology. Areas of these countries still have available absorption capacity before reaching critical environmental parameters, whereas other areas are approaching critical values or have already exceeded them. In such cases, both preventive and control measures are required. The social and economic requirements for beneficial environmental planning must be determined, together with the choice of proper technologies. In general, environmental considerations have not been as well integrated into national planning as they could have been. Furthermore, when new processes, products and technologies are considered, they may be faced with stringent prevention measures, abatement devices, protective legislation or other laws and regulations that may be outdated or altogether deficient; consequently, political solutions are likely to vacillate between punitive actions and voluntary commitment. In such cases, there is an urgency for both preventive and control measures.

46. Most of developed countries are urgently facing the problems of pollution prevention and control since, in most cases, their absorption capacity is rapidly reaching, or has already reached, critical environmental limits. In such cases, environmental quality standards have been formulated and environmental considerations have been introduced into national planning. Furthermore, emphasis is placed upon developing technologies that are environmentally beneficial, and industry is encouraged (in many cases, even forced) to search for new processes and products. Since solutions may not be readily available, the urgency of environmental problems has reached the point at which serious consideration is being given to decreasing the rate of economic growth; this is especially true in many areas of the most developed countries.

The range of solutions available

47. Solutions to some extremely urgent environmental problems caused by industry may not be readily available, in which case additional research and development are required. Generally, however, this situation exists only in the most developed countries. For the types of problems

generally facing the developing countries, a range of both preventive and control technologies and methodologies are available. However, coping with the problems of reducing potential or actual environmental disturbances associated with industrialization demands close co-operation between physical and economic planners on the one hand and technolgists and entrepreneurs on the other.

48. The examples given below will serve to illustrate that the available technologies and methodologies can range from the simple to the extremely complex, and that in many cases they can be utilized without significantly increasing costs. The list of examples is not intended to be exhaustive, nor is any attempt made to rank or classify them; the only purpose is to illustrate that a range of potential solutions is available to policy-makers and to industry in both the developing and the developed countries.

49. Physical and economic planning. Industrialization is bringing with it economic expansion and rising standards of living and, in turn, consequent increases in the demand for goods and services. These increased rates of consumption, coupled with the concentration of an expanding population and industry, produce environmental pressures. Such interactions and their consequences can only be obviated by careful planning to achieve optimal conditions and to maintain an adequate quality of environment. There are many aspects of planning, but the following will serve to illustrate its importance:

(a) Physical location of individual industrial units. Industry need not become a public health hazard. Topographical and climatic considerations can be taken into account when planning industrial sites so that the effects of pollutants, odors and noise on human settlements may be minimized or altogether eliminated. For example, an industrial plant may be located so that the prevailing winds may disperse potential pollutants away from neighbouring cities. Care in siting any plant and in-process engineering can usually minimize nuisances and hazards.

Pre-investment studies for new facilites should therefore include an evaluation of the environmental impact of the proposed location.

(b) Growth centers and industrial estates. A genuine economic and social development of depressed rural areas and the necessary redistribution of population away from overpopulated conurbations can succeed through the creation of new growth centres, which can provide the impetus required for a redistribution of industrial activities. These growth centres, carefully chosen and planned to make effective use of land and resources, help to avoid uncontrolled growth, which is causing many environmental problems. Industrial estates, with links designed between related industries and adequate provision of common services, can be used in the planned introduction of industry in new areas. This technique reduces the investment required by individual enterprises and serves as an incentive to the establishment of new industries.

(c) Choice of industry and its location. Attention is being given to ways of achieving planned growth of industries and urban centres. This is of particular importance in developing countries with largely rural populations that are becoming increasingly involved in industry and pressing upon urban centres. Industrial development can constitute a means of reducing disparities between the economic resources of different regions.

(d) Mathematical and economic programming models. For complex planning purposes, a quantification of alternative economic possibilities may be necessary. One way of doing this is by making use of a mathematical model. Since the interrelationships between the economic structure of an area and the environment is often quite complex, the construction of such a model offers the

possibility of evaluating the preferences of the community against the use of alternative production factors, thereby indicating the influence of development upon the environment. 5/ Generally, the construction of such models requires sophisticated computing equipment, extremely detailed data and specialists concerned with model construction.

50. Options in production-processing techniques. New industries in developing countries often have a choice of options in processing technologies, including recently developed ones. These can be carefully evaluated with regard to their costs and benefits, taking into account the need to protect or reduce environmental disturbances. A new process with a higher investment cost but which provides environmental controls may be preferable to a cheaper alternative process that would require environmental controls to be added later at high cost.

51. Appropriate choice of technology. In many cases intermediate technologies, with high labour demands, small plant size and less reliance on energy are often more appropriate to the needs of developing countries than sophisticated, capital-intensive processes requiring highly trained skilled workers. This approach involves matching the available human resources, the social structure and the size of the market. On the other hand, the sophisticated capital-intensive technologies may produce less pollution because of increased efficiency and automation. For example, large-scale highly mechanized canning operations may be preferable to small-scale labour-intensive canning operations.

5/ Many mathematical and economic programming models for such purposes have been constructed in the past several years; many have been published. One of the consultants who reviewed this paper has submitted a description of such a model to UNIDO. The paper, entitled "An operational mathematical programming model for the planning of economic activities in relation to the environment", is available upon request from the Industrial Technology Division of UNIDO.

52. Product selection. Changes in the end product, for example, to provide for those which have a long life, as contrasted to those aimed at early obsolescence, can both conserve raw materials and reduce the amount of materials discharged to the environment.

53. Utilization of wastes and residues. Specific economies may result and considerable reduction of pollutants ensue, from the use of three similar techniques: re-use, recycling and reclamation. Re-use denotes using a material or product more than once in its existing form as, for example, continuing to use containers instead of scrapping them after each use. Recycling takes the waste or finished article and reintroduces it into the production cycle for the manufacture of the same produce; for example, waste water may be treated and recycled instead of being discharged as effluent. Reclamation consists of reprocessing an article for use in the manufacture of a different product. For each individual process and product, an examination is needed to determine the feasibility of these techniques. In many cases, it has already been illustrated that these techniques can result in increased profits as well as reducing environmental contamination.

54. Infrastructural measures. Industrial development requires an adequate infrastructure to permit the flow of materials and finished goods, as well as for management and commercial purposes. It is also essential that water, drainage, electricity and other services be available at reasonable costs. Additional infrastructural developments are called for, including appropriate financial and related economic mechanisms, such as tax structures (including incentives), reduced tariffs and import duties, and access to money markets. These same measures may be effectively utilized as available solutions to environmental problems. Furthermore, a missing link usually found in a developing country's infrastructure is an indigenous industry to fabricate pollution-abatement equipment required by other industries; such countries should encourage the development of this industry.

A generalized model approach

55. A country that is conscious of environmental criteria will determine its own short- and long-range social requirements with respect to the quality of its environment. It will take into account the minimum appropriate standards and development possibilities, the availability of resources over a long-term period, the acute problems posed for environmental quality and the use of industrial development to enhance the human environment.

56. An appropriate organization or industry itself, conscious of environmental criteria, can obtain useful information through a proper research activity that draws on existing knowledge and practices. For such prognostic efforts, no large-scale research and development is required; a check of the literature, etc. on an international scale will suffice to disclose many current scientific and technical advances available for industrial development which are beneficial to the environment.

57. Once the political decision regarding social requirements for a country has been made and a country is in possession of available scientific and technical data and practices, it can begin to develop appropriate policies and programmes for guiding environmentally beneficial industrialization. The harmonization of social requirements with optimal industrial development in conformity with environmental standards can then be institutionalized. Institutional arrangements can take a variety of forms (e.g. governmental agencies, scientific advisory bodies and public associations); however, the managers and representatives of industry play a special role and should be identifiable partners in all such arrangements.

58. The above generalized approach, which takes the most recent developments into account, is outlined below in broad terms. Details of the general outline must be filled in on the basis of specific goals and objectives, available information and the specific purposes to be served. Solutions to specific environmental problems with regard to industrial development may then be formulated within this framework as follows:

Establish long- and short-term social and economic requirements, as well as appropriate environmental standards. (These requirements should be formulated on the basis of appropriate applied research and development technology.)

Establish appropriate institutional activities regarding:

- Physical planning (national and local);
- Economic planning;
- Administrative and legal planning, including mechanisms for both prevention and control;
- Research and training.

Develop the informational and promotional activities (required for general participation in the solution of industrially oriented environmental problems).

This general framework can be used for the purpose of obtaining full co-operation between policy-makers, the public and industrial managers and representatives.

CHAPTER III

RECOMMENDATIONS FOR ACTION

59. Direct action aimed at improving or maintaining environmental quality must clearly be undertaken at the national level, with each country pursuing policies appropriate to its particular conditions. Among those will be availability of financial and other resources and the political, institutional, social and cultural framework.

60. Previous sections of this paper have emphasized that industrial development will have a direct impact - positive, negative or both - upon the human environment. In this context, it has considered the general types of consequences that can be expected from industrial processes and products and the range of available approaches for the management of the environment with regard to industry. It should be obvious from this presentation that additional actions of various types are required.

61. The following policy-oriented recommendations with respect to industrial development are categorized by the major agenda items to be discussed at the United Nations Conference on the Human Environment, to be held in Stockholm in June 1972. It is emphasized that these recommendations are neither complete nor exhaustive but are only an invitation to further work and thought. In some cases the recommended action should be undertaken at the national level, whereas others would have to be implemented at the regional or international levels. A number of groups, bodies and/or organizations can assist in implementing the recommendations and develop them in more detail. For example, annex 4 describes UNIDO and its functions, whereas annex 5 describes UNIDO's environmental policies and activities.

62. The planning and management of human settlements for environmental quality. Among the most serious problems which the rapidly growing population of the world is facing are those related to human settlements. It is recommended that the industrial component of human settlements

and environmental problems of industrial origin be given special attention. In this context, it is recommended that stress be laid on the appropriate location and siting of industrial plants and to the various means of preventing and abating the effects of pollution, including improvements in waste-disposal systems.

63. The environmental aspects of natural resources management. When natural resources are exploited, there is an inevitable effect upon the environment. A direct link exists between such exploitation and industrial development. Consequently, it is recommended that the industrial component of natural resources management be given special attention. In this connexion, it is recommended that the ministries or organizations concerned with natural resources development and industrial development establish policies and programmes that will ensure that industrial activities can be undertaken without degrading the natural environment. Furthermore, since some of the technologies associated with these industries cause them to be among the heaviest polluters, additional attention must be given to development and application of improved technologies.

64. Identification and control of pollutants and nuisances of broad international significance. Industrial products and processes are generally considered to be among the primary producers of pollutants and nuisances. Consequently, the industrial sector is generally looked upon as the sector that should control their emission. An understanding of the complete cycle of any specific industry would demonstrate industry's responsibility to eliminate pollution and waste caused by its processes and products. It is therefore recommended that national and international studies be undertaken to identify the sources and extent of industrial pollutants and nuisances. After their sources and extent have been identified, appropriate control policies and programmes can be undertaken. In this context, it is further recommended that industry itself, with the aid of appropriate national, regional and international organizations, be mobilized to use these wastes or pollutants as additional sources of raw materials, which is the best form of control.

65. Educational, informational, social and cultural aspects of environmental issues. In many of the most highly developed countries, industrial processes and products are blamed for most of their environmental degradation. While this is to some extent true, it is emphasized that industry itself was generally responding to the social, cultural and economic conditions that prevailed during its development. It is therefore recommended that educational, informational and social programmes and activities be undertaken that emphasize that industrial development is a necessary part of development programmes. In this connexion, it is recommended that special attention and emphasis be given to the fact that industry generally responds to the existing and projected social, cultural and economic conditions. Emphasis should also be placed upon identifying and enunciating the responsibilites of industries in this regard.

66. Development and the environment. Concern with developmental goals and objectives need not be incompatible with environmental goals and objectives. A developmental strategy with environmental parameters can be formulated. It is recommended that each country define for itself the minimum environmental standards that it is seeking with regard to industrial development and measure its progress towards these norms by developing environmental indicators. In this connexion, it is also recommended, in order to incorporate the environmental parameters in development planning, that more attention be devoted to the areas concerning land-use policy, physical planning and policies regarding the physical location of industry.

67. International organizational implications of action proposals. It is recommended that one international organization be designated to co-ordinate all industrial development policies, programmes and activities that have an impact upon the environment. This organization should have the following functions: to act depository of data, to provide advice and technical assistance, to conduct studies and assist in formulating guidelines, to provide for necessary training and to maintain a file on experts. In this connexion, since UNIDO has the

mandate for accelerating the industrialization of the developing countries and, to some extent, is already performing some of the above functions, it could be designated the international organization to serve in this co-ordinative role.

ANNEX 1

SPECIFIED FACILITIES DISCHARGING WASTES [1/]

The following list of specified facilities is not intended to be complete nor intended to show the magnitude of these substances; rather it is representative of the industrial processes which discharge, to some extent, harmful substances:

TOXIC SUBSTANCES	SPECIFIED FACILITIES [a/]
Mercury and its compounds	25(a), (b), 26(a), (b), (e), 27(a), (b), (j), (k), 28(e), 46(a), (b), (d), 47(b), (c), (d), (e), 62(d), (e), (f), 63(d), (e).
Cadmium and its compounds	26(a), (b), (c), (e), 27(a), (b), (j), (k), 37(a)....(p), 43(a), 46(a), (b), (d), 53(a), (b), 62(e), (f), 66(a).
Lead and its compounds	26(a), (b), (e), 27(a), (b), (j), (k), 46(a), (b), (d), 47(b), (c), (d), (e), 53(a), (b), 72(c), (f), 63(c), (e).
Organophosphorous compounds	46(a), (b), (d), 49(a).
Chromium and its compounds	22(b), 26(a), (b), (e), 27(a), (b), (j), (k), 32(a), (b), (c), (d), 46(a), (b), (d), 47(b), (c), (d), (e), 63(b), (e), 65(a), 66(a).
Arsenic and its compounds	22(b), 24(a), (b), (c), (d), (e), 27(a), (b), (j), (k), 47(b), (c), (d), (e), 62(a), (b), (e), (f), 65(a).

a/ The numbers that appear here correspond to those listed below.

1/ Based upon A/Conf. 48/IWGMP/Inf. 10, 9 November 1971, submitted by the Japanese Delegation to the Secretariat of the UN Conference on the Human Environment with regard to Agenda Item 4(a).

SPECIFIED FACILITIES

1. MINING AND COAL WASHING

   (a) Ore separation facilities, (b) coal dressing facilities, (c) neutralization and sedimentation facilities of mine water, (d) solids separation facilities from water used for digging.

2. MEAT PACKING AND POULTRY PROCESSING

   (a) Initial preparation facilities, (b) washing facilities, (c) cooking facilities.

3. SEAFOODS PROCESSING

   (a) Initial preparation facilities, (b) washing facilities, (c) dehydration facilities, (d) screening facilities, (e) cooking facilities.

4. CANNED AND FROZEN VEGETABLES AND FRUITS PROCESSING

   (a) Initial preparation facilities, (b) cleaning facilities, (c) pressing facilities, (d) cooking facilities.

5. MISO, SOY-SAUCE, EDIBLE AMINO ACID, GLUTAMIC ACID, VEGETABLE SAUCES AND VINEGAR MANUFACTURING

   (a) Initial preparation facilities, (b) cleaning facilities, (c) boiling facilities, (d) concentration facilities, (e) finishing facilities, (f) straining facilities.

6. WHEAT FLOUR MILLING

   (a) Washing facilities.

7. SUGAR MANUFACTURING

   (a) Initial preparation facilities, (b) washing facilities, (c) filtration facilities, (d) separation facilities, (e) refining facilities.

8. BAKERY AND CONFECTIONERY

   (a) Bean-jam processing facilities.

9. RICE CAKE AND MALT MANUFACTURING

   (a) Washing facilities.

10. SOFT DRINK MANUFACTURING AND BREWERIES

    (a) Initial preparation facilities, (b) cleaning facilities, (c) extraction facilities, (d) straining facilities, (e) boiling facilities.

11. FEEDSTUFF AND ORGANIC FERTILIZER MANUFACTURING

    (a) Initial preparation facilities, (b) washing facilities, (c) pressing facilities, (d) vacuum concentration facilities, (e) water flushing and deodorization facilities.

12. OIL AND FAT MANUFACTURING

(a) Initial preparation facilities, (b) washing facilities, (c) pressing facilities, (d) separation facilities.

13. YEAST MANUFACTURING

(a) Initial preparation facilities, (b) washing facilities, (c) separation facilities.

14. STARCH MANUFACTURING

(a) Soaking facilities, (b) washing facilities, (c) separation facilities, (d) waste pits.

15. DEXTROSE MANUFACTURING

(a) Initial preparation facilities, (b) filtration facilities, (c) refining facilities.

16. NOODLE MANUFACTURING

(a) Boiling facilities.

17. BEAN FOOD MANUFACTURING

(a) Boiling facilities.

18. INSTANT COFFEE MANUFACTURING

(a) Extraction facilities.

19. TEXTILE INDUSTRY

(a) Scouring facilities, (b) by-product processing facilities, (c) soaking facilities, (d) finishing facilities, (e) bleaching facilities, (f) dyeing facilities, (g) chemical treatment facilities.

20. WOOL SCOURING AND WASHING

(a) Wool scouring and washing facilities, (b) carbonizing facilities.

21. MAN-MADE FIBRE MANUFACTURING

(a) Extrusion facilities, (b) chemical treatment facilities, (c) recovery facilities.

22. CHEMICAL FINISHING OF WOODS

(a) Wet barker, (b) chemical soaking facilities.

23. PULP AND PAPER MANUFACTURING

(a) Soaking, (b) wet barker, (c) chipper, (d) digester, (e) accumulator for digester wastes, (f) chip refiner and pulp refiner, (g) bleaching facilities, (h) paper mill, (i) cellophane paper mill, (j) wet fibre plate facilities, (k) waste gas washing facilities.

24. FERTILIZER MANUFACTURING

(a) Filtration facilities, (b) separation facilities, (c) water jet breaking facilities, (d) waste gas washing facilities, (e) wet dust collector.

25. SODIUM HYDROXIDE AND POTASSIUM HYDROXIDE MANUFACTURING (MERCURY ELECTROLYSIS)

(a) Electrolyte refining facilities, (b) electrolyzing facilities.

26. INORGANIC PIGMENTS MANUFACTURING

(a) Washing facilities, (b) filtration facilities, (c) centrifuger (cadmium and its compounds), (d) water flushing separator (verdigris), (e) waste gas washing facilities.

27. INORGANIC CHEMICALS MANUFACTURING (INCLUDING ITEMS 25 AND 26)

(a) Filtration facilities, (b) centrifuger, (c) sulphur dioxide gas cooling and washing facilities (sulphuric acid), (d) washing facilities (activated carbon and carbon disulphide), (e) hydrochloric acid regenerating facilities, (f) reactor cyanides, (g) absorber and sedimentation facilities (iodines), (h) sedimentation facilities (saline magnesia), (i) water flushing facilities, (j) waste gas washing facilities, (k) wet dust collector.

28. ETHYLENE DERIVATIVES MANUFACTURING (CARBIDE PROCESS)

(a) Wet ethylene generating facilities, (b) washing facilities and still (acetate ester), (c) methyl alcohol still (polyvinyl alcohol), (d) still (acrylic acid ester), (e) vinyl chloride monomer washing facilities.

29. COAL TAR PRODUCTS MANUFACTURING

(a) Sulphuric acid washing facilities of benzene derivatives, (b) waste pits, (c) tar sodium sulphate reactor.

30. FERMENTATION INDUSTRY (EXCLUDING ITEMS 5, 10 and 13)

(a) Initial preparation facilities, (b) still, (c) centrifugal decanter, (d) filtration facilities.

31. METHANE DERIVATIVES MANUFACTURING

(a) Still (methyl alcohol and 4-chloromethane), (b) refining facilities (formaldehyde), (c) washing and filtration facilities (flow gas).

32. SYNTHETIC PLASTICS MANUFACTURING

(a) Filtration facilities, (b) water washing facilities, (pigments or lake dyes), (c) centrifugal decanter, (d) waste gas washing facilities.

33. SYNTHETIC PLASTICS MANUFACTURING

(a) Condensation reactor, (b) water washing facilities, (c) centrifugal decanter, (d) settling facilities, (e) cooling gas washer and still (fluoride plastics), (f) diluent still (polypropylene), (g) diluent still (polyethylene), (h) acid and alkali treatment facilities (polybutane), (i) waste gas washing facilities, (k) wet dust collector.

34. SYNTHETIC RUBBER MANUFACTURING

(a) Filtration facilities, (b) dehydration facilities, (c) washing facilities, (d) latex concentration facilities, (e) sedimentation facilities (styrene-butadiene, nitrile-butadiene and polybutadiene-gum).

35. ORGANIC GUM CHEMICALS MANUFACTURING

(a) Distillation facilities, (b) waste gas washing facilities, (c) wet dust collector.

36. SYNTHETIC DETERGENT MANUFACTURING

(a) Acid washing and separating facilities, (b) waste gas washing facilities, (c) wet dust collector.

37. PETROCHEMICAL INDUSTRIES (CARBOHYDRATES AND THEIR DERIVATIVES), (EXCLUDING ITEMS FROM 31-36 AND 51)

(a) Washing facilities, (b) separation facilities, (c) filtration facilities, (d) distillation and rapid cooling facilities (acrylonitrile), (e) distillation facilities (acetaldehyde, ethylene diamine), (f) acid and alkali treatment facilities (alkyl benzene), (g) distillation facilities and sulphuric acid concentration facilities (isoprophyl alcohol), (h) distillation and condensation reactor (alcohol), (i) gas cooling and washing facilities (phtalic acid anhydride), (j) acid and alkali treatment facilities (cyclohexane), (l) methyl alcohol distillation facilities and acid-alkali treatment facilities, (m) steam condenser (ethyl ketone), (o) methyl-alcohol recovery facilities and reactor (methyl-m-acrytate monomer), (p) waste gas washing facilities.

38. SOAP MANUFACTURING

(a) Initial preparation facilities, (b) salting-out facilities.

39. HYDROGENATED OIL MANUFACTURING

(a) Alkali-conditioning facilities, (b) deodorization facilities.

40. FATTY ACIDS MANUFACTURING

(a) Distillation facilities.

41. PERFUMERY MANUFACTURING

(a) Washing facilities, (b) extraction facilities.

42. GELATINE AND GLUE MANUFACTURING

(a) Initial preparation facilities, (b) lime soaking facilities, (c) washing facilities.

43. PHOTOSENSITIVE GOODS MANUFACTURING

(a) Washing facilities.

44. NATURAL RESIN MANUFACTURING

(a) Initial preparation facilities, (b) dehydration facilities.

45. WOOD CHEMICAL MANUFACTURING

(a) Furfural distillation facilities.

46. ORGANIC CHEMICALS MANUFACTURING (EXCLUDING ITEMS 28-45)

(a) Water washing facilities, (b) filtration facilities, (c) concentrator (hyrazide), (d) waste gas washing facilities.

47. PHARMACEUTICAL MANUFACTURING

(a) Initial preparation facilities, (b) filtration facilities, (c) separation facilities, (d) mixing facilities, (e) gas washing facilities.

48. GUNPOWDER MANUFACTURING

(a) Washing facilities.

49. PESTICIDES MANUFACTURING

(a) Mixing facilities.

50. REAGENT MANUFACTURING

(a) Processing facilities.

51. OIL REFINING INDUSTRY

(a) De-salting facilities, (b) crude petroleum distillation facilities, (c) desulphurization facilities, (d) washing facilities (volatile oil, kerosene, gasoline), (e) lubricant washing facilities.

52. LEATHER MANUFACTURING

(a) Washing facilities, (b) lime-soaking facilities, (c) tanning soaking facilities, (d) chrome bathing facilities, (e) dyeing facilities.

53. GLASS MANUFACTURING

(a) Grinding and washing facilities, (b) gas washing facilities.

54. CEMENT MANUFACTURING

(a) Centrifuger, (b) shaper, (c) wet conditioning facilities.

55. READY MIXED CONCRETE MANUFACTURING

(a) Batcher plant.

56. ORGANIC SANDBOARD MANUFACTURING

(a) Mixing facilities.

57. SYNTHETIC BLACK LEAD ELECTRODE MANUFACTURING

(a) Shaping facilities.

58. RAW POTTERY MATERIALS MANUFACTURING

(a) Water jet crusher, (b) separation facilities, (c) acid treatment facilities, (d) dehydration facilities.

59. MACADAM QUARRYING

(a) Water jet crusher, (b) separation facilities.

60. GRAVEL QUARRYING

(a) Separation facilities.

61. IRON AND STEEL INDUSTRY

(a) Tar and gas separation facilities, (b) gas cooling and washing facilities, (c) rolling facilities, (d) hardening facilities, (e) wet dust collector.

62. NONFERROUS METALS MANUFACTURING

(a) Reduction basins, (b) electrolysis facilities, (c) hardening facilities, (d) mercury refinery facilities, (e) waste gas washing facilities, (f) wet dust collector.

63. METALLIC GOODS MANUFACTURING AND MACHINERY INDUSTRY

(a) Hardening facilities, (b) surface treatment facilities (electrolysis) (c) cadmium electrode and lead electrode processing facilities, (d) mercury refining facilities, (e) waste gas washing facilities.

64. TOWN GAS AND COKE MANUFACTURING

(a) Coal-tar and gas-liquid separation facilities, (b) cooling and washing facilities, including desulphurization facilities.

65. ACID AND ALKALI TREATMENT FACILITIES OF METAL SURFACES

66. ELECTROPLATING FACILITIES

67. LAUNDRY

(a) Washing facilities.

68. PHOTOGRAPH DEVELOPING
    (a) Automatic washing facilities of film.

69. SLAUGHTERHOUSES

70. WASTE OIL TREATMENT FACILITIES

71. AUTOMATIC WASHING FACILITIES FOR AUTOMOBILES

72. NIGHT SOIL TREATMENT PLANTS

73. SEWAGE TREATMENT PLANTS

ANNEX 2

WORLD PRODUCTION OF SOME OF THE MOST IMPORTANT KNOWN WASTE PRODUCTS ACTING AS POLLUTANTS

Pollutant	Source, estimated production and effect of the pollutant
Carbon dioxide (CO_2)	Energy consumption in power production, industry, transport (including supersonic transports) and domestic use, mainly as the result of combustion of fossil fuels. 1967: 13,400,000 tons [1] (CO_2 in atmosphere, increasing 0.2% annually). Increase in the earth's surface temperature and decrease in temperature of stratosphere; destruction of forests.
Carbon monoxide (CO)	Iron foundries, petroleum refineries, motor vehicle exhaust. 1968: Foundries and refineries alone - 26,200,000 tons. Impairment of human respiration, changes in photochemistry of stratosphere.
Sulphur dioxide (SO_2)	Energy production, industry, domestic use of coal, steam-powered vehicles. 1968: From major industrial sources, excluding fuel consumption - 27,300,000 tons. Respiratory disease, acidification of lakes, reactions with particulate matter (cloudiness), damage to limestone buildings, textiles, flora.
Nitrogen oxides (NO_x)	Motor vehicle and aircraft, energy production, agriculture, forest fires, waste disposal, including dumping. 1968: United States only - 18,800,000 tons. Mathaemoglobinaemia in babies from nitrates in water, eutrophication, smog, increase in ultra-violet light due to decrease in ozone, loss of game, fish and other aquatic life.

1/ All references to tons are to metric tons.

Phosphates	Sewage, detergents, dumping, run-off from fertilized agricultural land, effluents from intensive animal farming units. 1969: United States only - 20,000 tons of phosphorus pentoxide (P_2O_5) equivalent Eutrophication, loss of game fish and other aquatic life.
Mercury (H_g)	Combustion of fossil fuels, chlor-alkali industry, electrical and paint manufacture, mining and refining processes, medical and research laboratories, fungicides, seed dressings, slimicides in agriculture and pulp and paper industry. 1968: 8,810 tons. Cumulative poisons affecting nervous system, death due to eating contaminated fish and shellfish, other food contamination.
Lead (Pb)	Anti-knock ingredient of motor fuel (10%), lead smelting, chemical industry, pesticides. 1968: 3,000,000 tons. Cumulative poison that inhibits enzymes and impairs cell metabolism: contamination of food, pollution of air and drinking water.
Cadmium (Cd)	Plating, metallurgical industry, pigments, impurity in superphosphate fertilizers. 1968: 14,100 tons. Poisons affecting reproduction, contamination of food.
Other toxic metals	Metal plating industry (chromium), water pipes and storage tanks (nickel, copper), industry (nickel, copper), fungicides (copper, tin). 1968: Chromium 2,000,000 tons, nickel 480,000 tons, copper 5,000,000 tons. Varying degrees of toxicity (copper is dangerous to fish), drinking water pollution, contamination of food.

Oil spillage	Tankers (25%), other ships (24%), run-off from transport wastes (22%), accidents from ships etc. (10%), refineries (14%), off-shore production (5%). 1969: 1,820,000 tons. Smog, fouling of beaches, adverse effects on fish and seafowl, carcinogenicity of some fractions.
Persistent organochlorine insecticides (OCI)	DDT, aldrin, dieldrin, heptachlor etc. used in agriculture, horticulture, forestry, food storage, home use, preventive medicine, industrial effluent (pesticide factories, wool and carpet treatment). 1968: United States only - 63,400 tons of DDT only. Contamination of food, possible carcinogenic effects, loss of fish and their food (very sensitive to OCI), reduction of beneficial insects resulting in new pests, severe reduction of population of some birds.
Polychlorinated biphenyls (PCBs)	Plastics industry, electrical industry, lubricants. Effects on fish, effects on wildlife.
Radionuclides	Nuclear fuel processing plants (99%), nuclear accidents, weapons testing, nuclear-powered ships. 1970: United States only - total accumulated fission products, 1,200 megacuries. Increase in genetic mutation, amounts in some foods make them dangerous to eat.
Particles	Man-made deserts, agriculture and forestry burning, incineration and domestic fires, energy production, industry, transport (unburned or partially burned fuel). 1970: United States only - airborne 11,450,000 tons. Respiratory disease, photosynthesis reduced, damage to filter feeding animals, smog, reduction of solar radiation reaching earth, increased cloudiness.
Solids	Rubbish dumps on land and in the sea, inadequate disposal of household wastes, dredging, discarding into ocean.

	Rapidly increasing non-biodegradeable substances. Damage to benthic fauna, ground water pollution, waste of productive land, increase in disease-bearing animals.
Heat	Large cities, power stations, especially nuclear ones. 1970: Thermal waste power, 5,500,000 megawatts. Local reduction of solubility of O_2 and eutrophication, local loss of species, deterioration of local climate, especially in towns.
Noise	Motor vehicles, aircraft (especially during take-off and sonic booms), mining, blasting. Loss of hearing, psychological effects on densely populated areas.
Antibiotics and other veterinary drugs	Sewage, effluents from intensive animal farming. Carcinogenic effects, production of resistant strains of disease organisms.
Micro-organisms	Night soil, sewage and hence water, shellfish and fish, contaminated food. Dissemination of disease organisms (cholera, typhoid, amoebic dysentery etc.), drinking water pollution, seafood pollution, danger to bathers.

FIGURE 1: SCHEMATIC DEPICTION OF MATERIALS FLOW

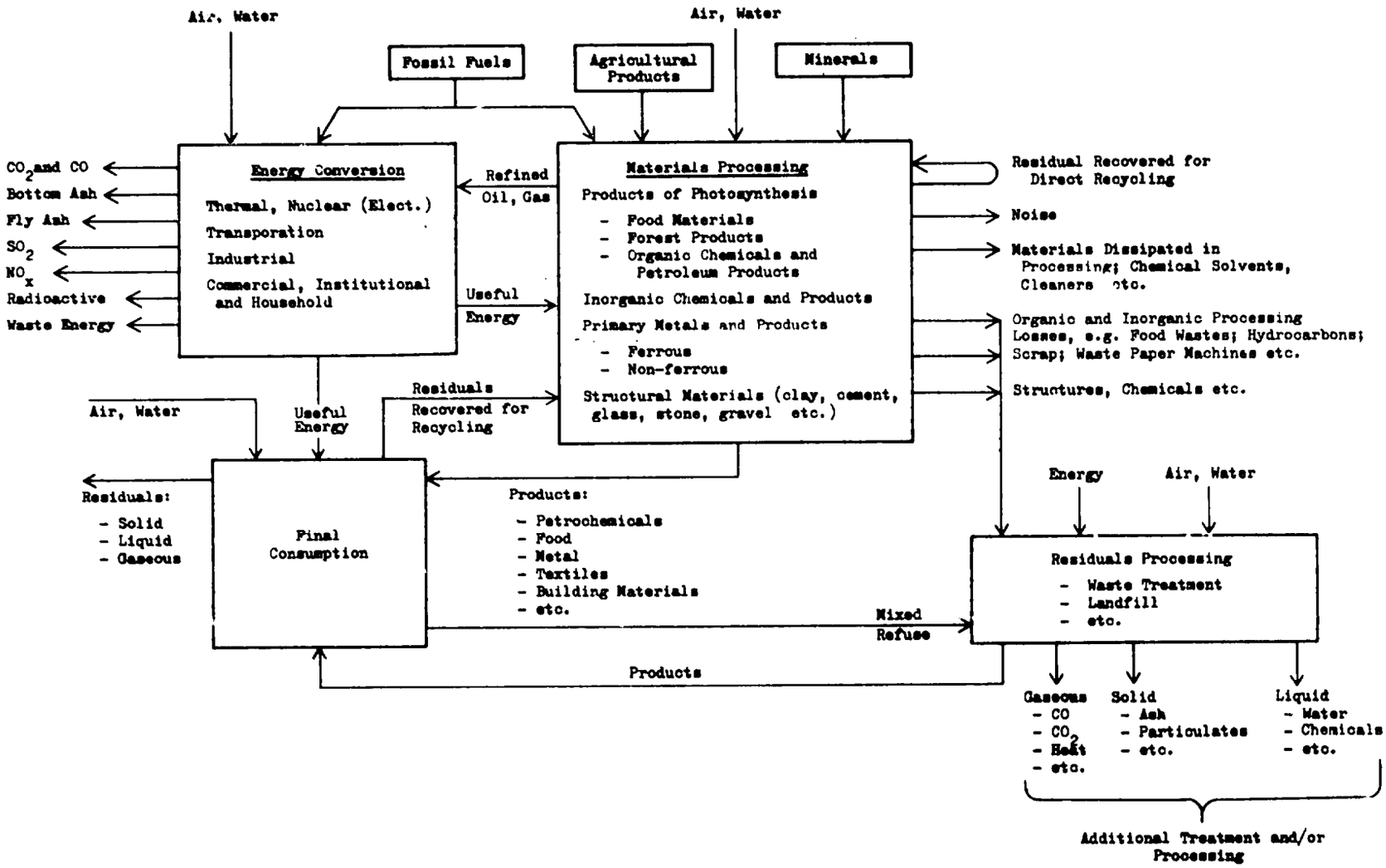


FIGURE 2: RESIDUALS FROM THE THERMAL ELECTRIC INDUSTRY

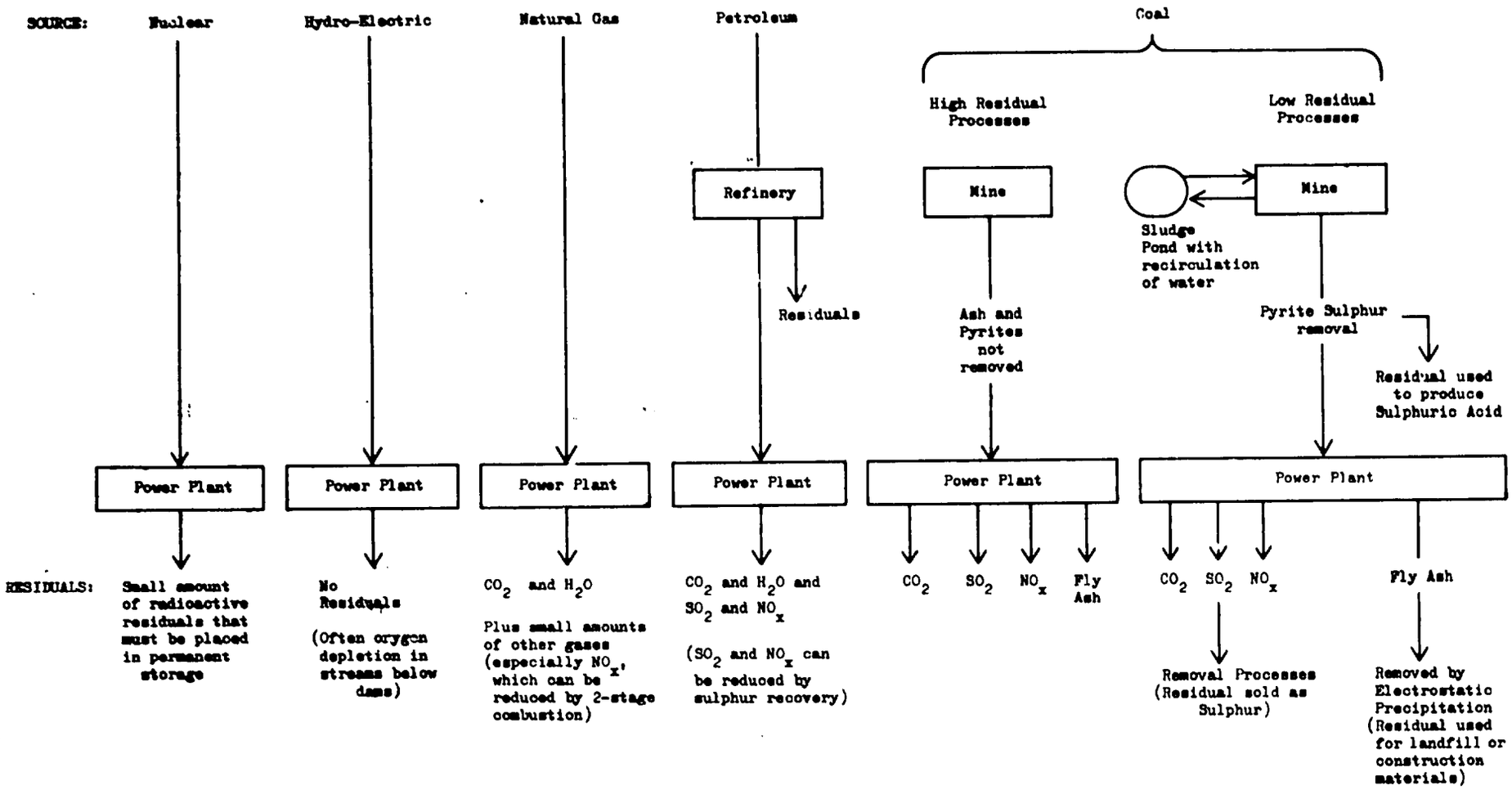


Figure 3: Environmental Cycle - common salt

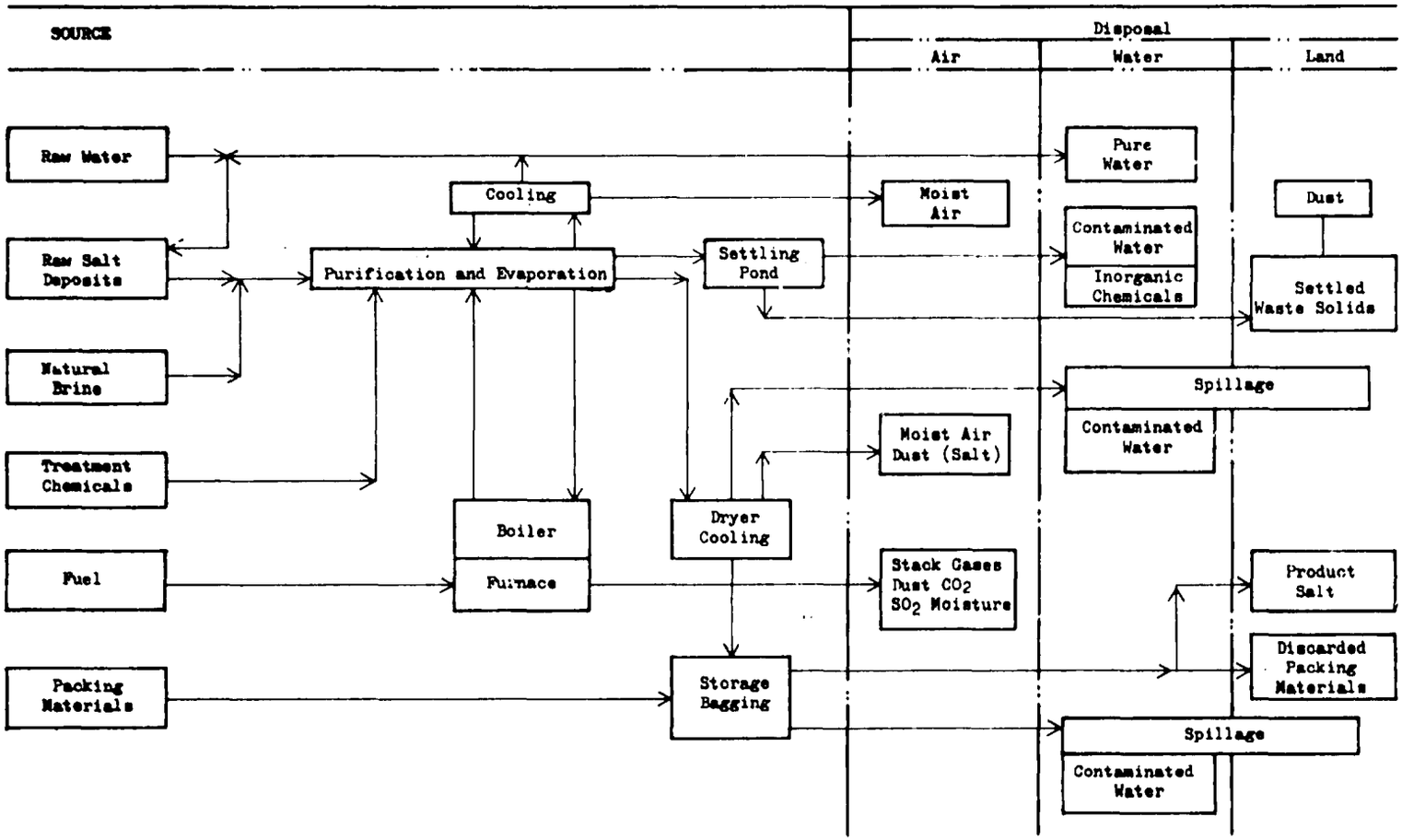


Figure 4: Environmental Cycle - potato processing

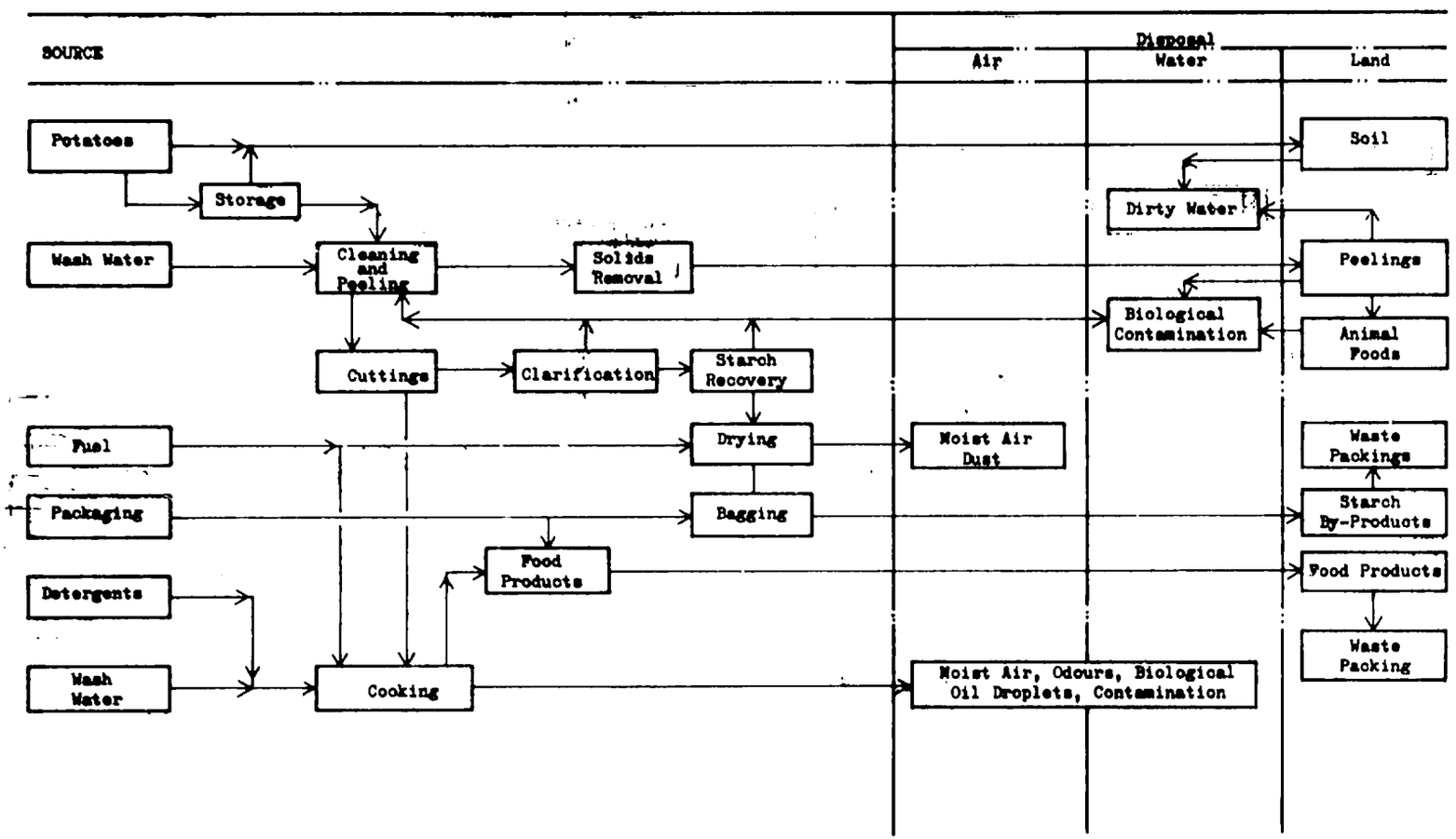
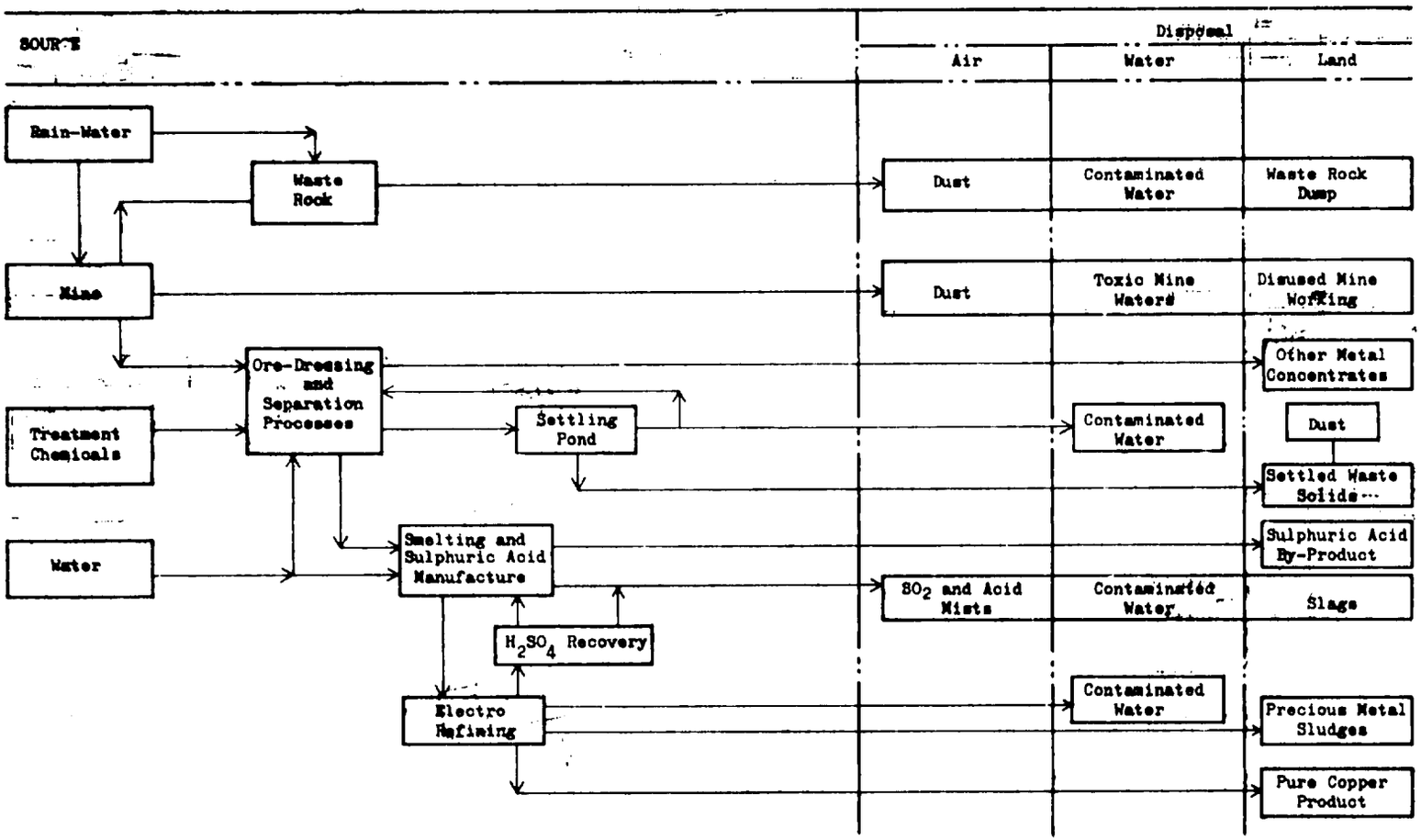


Figure 5: Environmental Cycle - copper production



ANNEX 4

UNIDO AND ITS FUNCTIONS

The United Nations Industrial Development Organization (UNIDO) was established on 1 January 1967 by the General Assembly of the United Nations to promote and accelerate the industrialization of the developing countries and was given the central role in co-ordinating all activities undertaken by the United Nations family in this field. Its headquarters are in Vienna, Austria.

Types of UNIDO Activities

The activities of UNIDO are of two general kinds, operational and supporting. The operational activities involve direct assistance to developing countries and consist of the following:

- The establishment, operation and management of industrial enterprises to promote domestic investment and increase external financing for specific industrial projects;
- The building of effective national organizations to administer industrial services;
- The preparation of industrial development programmes and specific projects;
- The training of staff;
- The solving of problems related to the exploitation and use of natural resources, industrial raw materials and by-products;
- The dissemination of information on new technologies and assistance to the developing countries to apply such information effectively;
- The promotion of national, regional and international action to achieve more rapid industrialization.

The supporting activities include studies, research, exchange of information and training designed to contribute to the effectiveness of operational activities. This category covers the compilation, analysis, publication and dissemination of data concerning various aspects of industrialization such as industrial technology, investment, financing, production, management and planning.

The Industrial Development Board

The principal policy-making body of UNIDO is the Industrial Development Board, whose 45 members are elected by the General Assembly from member states of the United Nations and its agencies for terms of three years. The Board meets once a year to formulate guidelines and policies for UNIDO and to approve its programme of activities.

Financing UNIDO's activities

Expenses for the administrative and research activities of UNIDO are borne by the regular budget of the United Nations. For its operational activities, UNIDO draws mainly on the resources provided by the United Nations Development Programme (UNDP) and on a part of the regular budget of the United Nations, as well as on voluntary contributions from member Governments.

How to obtain assistance from UNIDO

Procedures for the submission of requests for assistance vary from programme to programme. The UNDP Resident Representatives advise the Governments on these matters. Although the nature and extent of requests vary depending on the circumstances, the following criteria are common to all of them:

- Assistance is granted only at the request of Governments in a formal communication emanating from the concerned authorities after establishing their own requirements and priorities.

- Requests of Governments are to be submitted through the Resident Representative of UNDP and are transmitted simultaneously to UNIDO and UNDP for processing and approval;
- A request may be formulated through the combined efforts of the national authorities and technical assistance experts, including UNIDO staff, the Industrial Field Adviser, and the UNDP Resident Representative;
- Official requests should normally contain a description of the project, its objectives, duration, the number of experts and the equipment required, and the nature or amount of local costs and counterpart contributions that would be provided by the recipient Government;
- Upon receiving the request, preliminary negotiations will be carried out by the Resident Representative with the requesting Government on the nature of the request and the source and availability of funds;
- Requests for urgent short-term assistance may be made under the programme of Special Industrial Services (SIS), while medium-term advisory missions and pre-investment and pilot projects comprising experts, fellowships and equipment can be financed through the normal procedure of the UNDP;
- Requests for assistance when received by the UNIDO, are examined for their merit before putting them into action. In the event that any further information or revision is needed, arrangements will be made to assist the government in this regard;
- Recruitment of experts is undertaken by UNIDO. In all cases, prior approval for the proposed candidate will be sought from the Government concerned before appointment.

Special Industrial Services Programme

UNIDO provides aid at short notice to developing countries wishing to solve urgent industrial problems. This is the Special Industrial Services (SIS), which is administered jointly by UNIDO and the UNDP. In this programme, experts are sent for brief periods to advise on the solution of urgent technical problems.

ANNEX 5

UNIDO'S ENVIRONMENTAL PROGRAMMES AND ACTIVITIES

In fulfilling its mandate with regard to stimulating the industrial development of the developing countries, UNIDO must be aware of the policies, programmes and activities that bear on any aspect of this complex task. Consequently, it is concerned with the environmental benefits and problems associated with industrial development and especially with those of direct industrial origin.

At the request of governments and/or approval of the Industrial Development Board, UNIDO can provide assistance in environmental policies, programmes and activities as they relate to industrial development. A brief description of the areas in which UNIDO has provided, or is prepared to provide, expert services and other assistance, is presented below.

Development of policy guidelines, including environmental economics

UNIDO supports the establishment of appropriate policies for industry comprising provisions against overconcentration of polluting industries, as well as standards, guidelines and measures to prevent and resolve environmental conflicts.

UNIDO studies the economics of environmental quality and its implications for the development of the industrial sector. It gives support to the introduction of environmental criteria in the preparation and implementation of industrial projects and industrial development plans. In this context, UNIDO will commission a study on guidelines for the economics of environmental quality as it relates to industrial development.

The emergence of widely-accepted environmental criteria and standards will exert a strong influence on industrial activity. UNIDO is concerned with this aspect of the problem and is prepared to consider the development of some sort of environmental rating of different

industrial branches as a first step towards the formulation of such a policy. Furthermore, UNIDO is concerned that the process of industrialization will not be slowed by the adoption of such criteria and standards. Within this framework it can undertake comparative surveys and appraisals of proposed national standards relating to industrial pollutants and nuisances.

Industrial Development Planning and Industrial Location

In any development plan, the industrial component deserves special attention. In this context, UNIDO can help evaluate industrialization programmes with respect to the environment in national and international planning.

In industrial development planning, UNIDO can collect and disseminate information to assist with environmental criteria. One facet of these studies could be directed to the comparative advantages that developing countries may have with their relatively pollution-free environments and the setting of standards in relation to local conditions.

UNIDO can assist developing countries with specific locational problems by supplying guidelines and objective criteria for use in planning industrial siting so that environmental conflicts can be avoided or resolved.

The development and use of technology for prevention of pollution and utilization of waste

UNIDO supports the development and transfer of suitable processes and technologies for minimizing harmful gaseous, solid and liquid emissions and for recovering valuable materials from wastes and pollutants.

In this context, UNIDO will pay specific attention to by-products and wastes. Many wastes can be more properly called unused assets, and their utilization will not only reduce the volume of industrial pollution, but will also increase profitability. UNIDO can assess the availability of such materials in the developing countries, collect information on

the technological processes available to turn them into profitable products, disseminate this information among interested countries and encourage them to adopt such processes for the profitable utilization of by-products that would otherwise be of no economic value.

UNIDO can collect and make available information to assist industry in developing countries to cope with pollution problems at the source. It can also assist in surveying, studying, inspecting and determining the amount of pollution arising from manufacturing units in different branches of industry.

Many developing countries possess raw material resources but lack the technology for the manufacture of equipment, chemicals and other supplies. Assisting these countries by providing the know-how is an area in which UNIDO has special competence.

It is generally much more economical to incorporate environmental protection schemes, processes and products at the onset of development than to rehabilitate a degraded environment. UNIDO can assist in identifying and providing special assistance in this area.

Production and use of monitoring, surveillance and control instruments

UNIDO is currently co-operating with several electrical and electronic research institutes that are responsible, amongst other things, for the design and production of measuring instruments. UNIDO will support the production of monitoring, surveillance and control devices to meet the demand that may be expected from developing countries in relation to the control of environmental quality. In addition, UNIDO can provide training in the proper use of such instruments.

Legal and institutional aspects

UNIDO can provide guidance to governments on the legal and institutional aspects of environmental management, ensuring at the same time that the criteria and standards to be adopted are within the techno-economic

possibilities of the industrial sector. In this context, UNIDO can help ensure that the standards that may be set will be realistic so that compliance with them will not involve the industrial sector in needless or excessive capital expenditures.

Other technical assistance

UNIDO can contribute technical assistance to developing countries in the various fields already mentioned by provision of expert services, training of local personnel, convening seminars, workshops and conferences to permit an exchange of information and views between countries and in institution building. Furthermore, UNIDO will assemble and maintain an up-to-date file on experts in the field of industrial development and environmental management and will support the training of national experts.

Co-operation with other organizations

The approaching partnership between industrial development and environmental quality enhancement poses a number of new concerns and needs. UNIDO can respond to these and expand its services accordingly. While UNIDO may well come to play the key role, it will increase its co-operation with the Food and Agriculture Organization, the World Health Organization and other organizations and specialized bodies in any programmes affecting industrial development projects. The co-ordination of programmesaims to integrate environmental considerations in industrial development.

UNIDO can sponsor and help provide, in co-operation with other organizations and agencies, mobile laboratories for the analysis of water and air purity.

UNIDO is ready to help co-ordinate national and international bodies and institutions concerned with environmental criteria in industrial development. UNIDO is available to assist in reviewing the technology of specific industries according to the standards of environmental quality desired. Advice and technical assistance also include support to feasibility

studies, including environmental criteria, and to regional pilot projects in industrial development and environmental management.

UNIDO can aid in establishing an industrial non-governmental organization (NGO). The United Nations needs industrial groups to advise it, and it will want to co-operate more closely with the managers of industry in order to help a world-wide mobilization of industry for environmental management.