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9. ABSTRACT

This volume of eight selected papers on the subject of environmental planning is one of five volumes of readings prepared for participants in the IPEAID seminar conducted at the University of North Carolina in March-April, 1975. The other four volumes are entitled Water Quality Management and Solid Wastes, Air Quality Management, Industrial Pollution, and Resources and the Environment. The authors and titles of papers included in this Volume I:

Varre, Remi. Environmental management, economic development, and social welfare: the economic basis for environmental considerations in socioeconomic development policies and planning.

Carroll, John B. The relevance of planning for land use and environmental impacts in industrializing countries.

Council on Environmental Quality. The economic impact of environmental programs.

Environment Directorate. Environmental standards: definitions and the need for international harmonization.

Francis, Walton J. A report on measurement and the quality of life, and the implications for government action of The Limits to Growth.

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READING REFERENCES

ENVIRONMENTAL PLANNING

VOLUME 1 OF 5

Including Master Table of Contents Vols. 1-5

Assembled By

F. Eugene McJunkin

International Program in Environmental

Aspects of Industrial Development

Department of Environmental Sciences and Engineering

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Chapel Hill, N.C. 27514

U.S.A.

1975 - 1976

INTERNATIONAL ENVIRONMENTAL PROGRAMS AT THE UNIVERSITY OF NORTH CAROLINA

The Department of Environmental Sciences and Engineering at the University of North Carolina has a long standing interest and involvement in international activities and programs concerned with environmental quality and, in particular, with the environmental problems of developing countries. Departmental activities have included special educational programs, on campus and abroad, long and short term; technical assistance; research and development; information transfer, including publications; and consulting and service activities by faculty and staff. These programs have included the International Program in Sanitary Engineering Design, the AID Engineers' Environmental Program, the International Program in Environmental Aspects of Industrial Development, the publication series Water Supply and Sanitation in Developing Countries, technical assistance to several overseas universities, and numerous technical studies.

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United States of America

INTRODUCTION

During March and April of 1975 the Department of Environmental Sciences and Engineering of the University of North Carolina conducted the second, on-campus session of its International Program in Environmental Aspects of Industrial Development (IPEAID). As with the 1973 Session IPEAID was sponsored by the Office of Science and Technology, U. S. Agency for International Development. And as in 1973, ten of the thirty participants were sponsored by the United Nations Industrial Development Organization.

The participants, primarily from developing countries, were mid-career and senior level officials with responsibilities for planning, promoting, regulating, or administering industrial operations, including education, research and development as well as manufacturing and mining. Although the participants were all professionals and included engineers, scientists, economists, and administrators, they had limited background and experience in environmental aspects of industrial development.

IPEAID was and is intended to improve the participants' comprehension and understanding of the environmental issues, effects, alternatives, and technologies associated with industrial development. Economics and public policy, technology, and human health effects were substantial components of the courses. Methodologies for anticipating and assessing potential environmental impacts of industrialization were stressed and reviewed in several case studies.

IPEAID and these volumes <u>do not</u> include detailed instruction for the technical specialist concerned with a specific pollution control or industrial manufacturing process. IPEAID does, however, provide an overview of available pollution control alternatives and technologies at a level of detail appropriate for individuals concerned with industrialization in general.

Although the course materials (and field trips) draw heavily on United States experience, IPEAID recognizes the differing socio-cultural-economic conditions and development priorities in the developing countries. The various institutional and legal approaches to pollution control in industrialized countries are presented not as normative or sole solutions but to provide an opportunity to examine the experience gained in trying alternative approaches.

To supplement the classroom lectures, seminars, and field trips; to reinforce the learning experience and help overcome language barriers; and to provide a basic reference library for permanent retention by the participants, IPEAID assembled an extensive collection of reading references. These are, in part, collected in these five volumes. Some were specially prepared by IPEAID staff, others were used with permission. They are published primarily in their original form; this compiler apologizes for the lack of uniform editorial format but believes this deficiency is outweighed by their usefulness.

In addition to the materials of these five volumes, each participant received copies of the following books or monographs:

Agency for International Development. Environmental Assessment Guidelines Manual. Washington, D.C. 159 pp. 1974.

Chanlett, Emil T. Environmental Protection. McGraw-Hill, Inc., New York. 569 pp. 1973.

Panel of Experts Convened by the Secretary-General of the United Nations Conference on the Human Environment. Founex Report on Development and Environment. Founex, Switzerland. 1971. As published in International Conciliation, No. 586, pp. 7-83, with commentaries by four panel members. January 1972.

Pescod, M.A. and Okun, D.A., Editors. Water Supply and Wastewater Disposal in Developing Countries. Asian Institute of Technology, Bangkok. 309 pp. 1971.

Stone, Ralph & Company, Inc. Decision-Makers' Guidebook for Industrial Pollution Control. Preliminary Edition, Volume I. U.S. Agency for International Development in Cooperation with: United Nations Institute for Training and Research, U.S. Department of Commerce, U.S. Environmental Protection Agency. 128 pp., includes several comprehensive bibliographies. February 1975.

Stone, Ralph & Company, Inc. Decision-Makers' Guidebook for Industrial Pollution Control. Preliminary Edition, Volume II. U.S. Agency for International Development in Cooperation with: United Nations Institute for Training and Research, U.S. Department of Commerce, U.S. Environemntal Protection Agency. 337 pp., includes several comprehensive bibliographies. February 1975.

United Nations Industrial Development Organization. Industrial Development and the Environment. Vienna. 1972. International Program in Environmental Aspects of Industrial Development. University of North Carolina, Chapel Hill, North Carolina, 55 pp. 1975.

World Bank. Environmental, Health, and Human Ecologic Considerations in Economic Development Projects. Washington, D.C. 142 pp.

The additional reading references are assembled by subject in five volumes:

1. Environmental Planning
2. Water Quality Management/Solid Wastes
3. Air Quality Management
4. Industrial Pollution
5. Resources and the Environment

These five volumes plus the above listed items were intended to provide broad coverage of the environmental aspects of industrial development.

These volumes were prepared for IPEAID participants. A limited number of sets are available for libraries of international organizations.

F. Eugene McJunkin
Chapel Hill, North Carolina
February 1976

A DEDICATION

These five volumes are dedicated to George E. Barnes, Professor Emeritus of Sanitary Engineering, in appreciation of his many contributions to international programs at the University of North Carolina.

MASTER TABLE OF CONTENTS: VOLUMES 1 - 5

VOLUME NO. 1

ENVIRONMENTAL PLANNING

INTRODUCTION

AUTHOR	PAPER	PAGE
Barre, Remi.	"Environmental Management, Economic Development, and Social Welfare: the Economic Basis for Environmental Considerations in Socio-Economic Development Policies and Planning."	1 - 1
Carroll, John B.	"The Relevance of Planning for Land Use and Environmental Impacts in Industrializing Countries."	1 - 71
Council on Environmental Quality.	"The Economic Impact of Environmental Programs."	1 - 109
Environment Directorate.	"Environmental Standards: Definitions and the Need for International Harmonization."	1 - 141
Francis, Walton J.	"A Report on Measurement and the Quality of Life" and "The Implications for Government Action of The Limits to Growth."	1 - 169
Kaiser, Edward J.	"Urban Land Use Planning for Industrial Development."	1 - 211
Leak, Robert E.	"Speech Before United Nations Industrial Development Committee."	1 - 257
U.S. Atomic Energy Commission.	"Preparation of Environmental Reports for Nuclear Power Plants."	1 - 265

AUTHOR INDEX 1 - 345

SUBJECT INDEX 1 - 351

VOLUME NO. 2

WATER-QUALITY MANAGEMENT

SOLID WASTES

Barnes, George E.	"Measuring and Monitoring of Waste Flows."	2 - 1
_____.	"Illustrated Lecture on Sewage Treatment Methods and Devices."	2 - 13
_____.	"Sewage and Industrial Wastes."	2 - 31

AUTHOR	PAPER	PAGE
Carroll, John B., and McJunkin, F. Eugene.	"A Collection of Source Materials on the Subject of Solid Waste Management."	2 - 47
Federal Water Pollution Control Administration.	"A Primer on Waste Water Treatment."	2 - 163
Feuerstein, Donald L.	"Ocean Outfall Disposal Systems."	2 - 189
Kriz, G.J., et al.	"Beef Cattle Waste Management Alternatives."	2 - 201
_____.	"Dairy Waste Management Alternatives."	2 - 231
_____.	"Poultry Waste Management Alternatives."	2 - 257
_____.	"Swine Waste Management Alternatives."	2 - 277
Lamb, James. C. III.	"Sources of Water" and "Key Factors in Selecting Water Sources."	2 - 295
_____.	"Stream Sampling: Location, Timing, and Types of Samples."	2 - 297
_____.	"Summary of Public Health Service Drinking Water Standards, 1961.	2 - 307
McGauhey, P.H., and Golucke, Clarence G.	"Control of Industrial Solid Waste."	2 - 311
Okun, Daniel A.	"Planning for Water Management Projects."	2 - 321
_____.	"Sources of Water."	2 - 331
.	"Water and Industrial Development."	2 - 333

VOLUME NO. 3

AIR QUALITY MANAGEMENT

Kornreich, Lawrence D.	"Air Pollution and Its Control."	3 - 1
Peterson, James T.	"Diffusion Processes at Large and Small Scales."	3 - 95
Reist, Parker C.	"Control of Gaseous Emissions by Combustion."	3 - 103
Turner, D. Bruce.	"Workbook of Atmospheric Dispersion Estimates."	3 - 117

VOLUME NO. 4

INDUSTRIAL POLLUTION

AUTHOR	PAPER	PAGE
Amdur, Mary O.	"Industrial Toxicology."	4 - 1
Anderson, A.E.	"Environmental Consideration in the Location of Industry."	4 - 15
Barnes, Edgar C.	"Ionizing Radiation."	4 - 31
Barnes, George E.	"Plating and Metal Finishing."	4 - 53
Fraser, D.A.	"The Environment and the Industrial Workers."	4 - 57
_____.	"Principles of Industrial Toxicology."	4 - 67
International Bank for Reconstruction and Development.	"The World Bank, Industrial Development, and the Environment."	4 - 87
Irish, Don D.	"The Significance of the Occupational Environment as Part of the Total Ecological System."	4 - 151
Lamb, James C. III.	"Bibliography on Industrial Wastes."	4 - 155
_____.	"Guidelines for the Control of Industrial Wastes." 3. Cane-Sugar Industry Wastes."	4 - 157
_____.	"Guidelines for the Control of Industrial Wastes: 4. Livestock Wastes."	4 - 171
_____.	"Guidelines for the Control of Industrial Wastes: 5. Pulp and Paper Manufacturing Wastes."	4 - 189
_____.	"Guidelines for the Control of Industrial Wastes: 6. Metal Finishing Wastes."	4 - 207
_____.	"Summary of Industrial Waste: Its Origin, Character, and Treatment."	4 - 219
Little, Linda West.	"Select Bibliography Relating to Brine Wastes and Their Treatment."	4 - 225
_____.	"Waste Handling Problems of the Pickle and Olive Industries."	4 - 227
Peterson, Jack E.	"Principles of Controlling the Occupational Environment."	4 - 237
State Committee for Construction (GOSSTROJ) of the Council of Ministers of the USSR.	"Sanitary Norms and Standards for Planning Industrial Undertakings."	4 - 245

VOLUME NO. 5

RESOURCES AND THE ENVIRONMENT

	PAGE
Barre, Remi. "Energy and the Environment."	5 - 1
_____. "The Environmental Impact Statement as Practiced in the United States."	5 - 53
Carmichael, Jack B. Environmental Considerations in the Planning and Evaluation of Development Projects. Excerpts included:	
"Case Study: Ecological Survey of the Menta River in the Country of Farmington."	5 - 95
"Case Study: Hydroelectric Project for the Country of Odi."	5 - 107
"Case Study: Iron Ore Project in the Country of Edel."	5 - 119
"Case Study: Nickel Ore Mining and Refinery Project in the Country of Teleroy."	5 - 129
Chanlett, Emil T. "Environmental Quality Issures."	5 - 139
Christman, R.F. "Human Population Growth."	5 - 169
Cloud, Preston. "Mineral Resources in Fact and Fancy.'	5 - 187
Daly, Herman E. "Electric Power, Employment, and Economic Growth: A Case Study in Growthmania."	5 - 215
Environment Directorate. "Report on Environmental Impact of Airport Development."	5 - 243
Gregory, Delores. "Notes on International Availability of Publications of the U.S. National Technical Information Service and the U.S. Environmental Protection Agency."	5 - 261
U.S. Environmental Protection Agency. "Common Environmental Terms - A Glossary."	5 - 281

TABLE OF CONTENTS: VOLUME 1 OF 5

ENVIRONMENTAL PLANNING

INTRODUCTION

AUTHOR	PAPER	PAGE
Barre, Remi.	"Environmental Management, Economic Development, and Social Welfare: the Economic Basis for Environmental Considerations in Socio-Economic Development Policies and Planning."	1 - 1
Carroll, John B.	"The Relevance of Planning for Land Use and Environmental Impacts in Industrializing Countries."	1 - 71
Council on Environmental Quality.	"The Economic Impace of Environmental Programs."	1 - 109
Environment Directorate.	"Environmental Standards: Definitions and the Need for International Harmonization."	1 - 141
Francis, Walton J.	"A Report on Measurement and the Quality of Life" and "The Implications for Government Action of The Limits to Growth."	1 - 169
Kaiser, Edward J.	"Urban Land Use Planning for Industrial Development."	1 - 211
Leak, Robert E.	"Speech Before United Nations Industrial Development Committee."	1 - 257
U.S. Atomic Energy Commission.	"Preparation of Environmental Reports for Nuclear Power Plants."	1 - 265

AUTHOR INDEX 1 - 345

SUBJECT INDEX 1 - 351

ENVIRONMENTAL MANAGEMENT, ECONOMIC DEVELOPMENT, AND SOCIAL WELFARE

The Economic Basis for Environmental Considerations in Socio-Economic Development Policies and Planning

Prepared

by

Rémi Barré

With the Assistance of

F. Eugene McJunkin

January 20, 1975

University of North Carolina
Chapel Hill, North Carolina

ENVIRONMENTAL MANAGEMENT, ECONOMIC DEVELOPMENT, AND SOCIAL WELFARE

Objectives i-ii

Introduction

1. Social Welfare, the Environment and the General Equilibrium Theory Framework 1

   1.1 Some Definitions

   1.2 General Equilibrium in a System of Private Markets

   1.3 Assumptions of the General Equilibrium Theory

   1.4 The Relevance of this Theory as a Framework

   1.5 Introducing the Environment

2. Externalities, Social Efficiency, and Environmental Management 8

   2.1 The Concept of Externality

   2.2 The pervasiveness of Externalities

   2.3 The Economics of Externalities

   2.4 The Social optimal Degree of Pollution Concept

   2.5 The Theoretical Solution to Reach It

3. Measurement of Costs and Benefits Associated with the Environment 19

   3.1 Desaggregation of Social Costs in Components Characterized by a Type of Measurement and Type of Cost

   3.2 Introducing the Multiple Objective Welfare Function

   3.3 The Process of Determination of the Social Optimal Degree of Pollution

   3.4 In Search of the Economically Efficient Degree of Pollution

4. Policies Instruments of Allocation of Environmental Costs 28

4.1 Aiming at the "second best" Instead of the Optimum

4.2 The Allocation of Environmental Costs

4.3 Criteria for Evaluation of the Best Suited Policy

Conclusions 33

Appendix A: Environment, Developing Countries, and International Trade 37

Appendix B: On Efficiency in a Multi-objective Planning Context 45

Bibliography: 47

Part I The Economics of Natural Resources and the Environment: Theoretical Studies 48
Part II The Economics of Natural Resources and the Environment: Empirical Studies 50
Part III Welfare Economics, Public Expenditure, and Collective Action 50
Part IV Pollution Control, Environmental Protection Policies and Natural Resources Management 52
Part V Cost-Benefit Analysis 53
Part VI The Environment and the Distribution of Income 54
Part VII Multi-Objective Planning 54
Part VIII The Environment and Technical Change 54
Part IX Environmental Quality and Economic Growth 55
Part X The Environment, Trade, and International Implications 55
Part XI Pollution and Ecology: Overviews 56
Part XII Environmental Pollution as a Threat to the Equilibrium of the Ecological System 57

ENVIRONMENTAL MANAGEMENT, ECONOMIC DEVELOPMENT AND SOCIAL WELFARE

(The Economic Basis for Environmental Considerations in Socio-economic Development Policies and Planning)

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Objectives of the Paper

This paper is aimed at giving the framework of a rationale for:

1. Including environmental considerations in planning for development.
2. Deciding the degree of environmental protection consistent with the overall objectives of a particular society.
3. Choosing the policies and procedures best suited for this task.

It will be rather conceptual in nature in order to be adaptable to a wide variety of politico-economic situations, but concrete enough in its results in order to be relevant in terms of action.

The word "environment" will have here the broad but precise meaning: all the natural (within a country or internationally) resources, which is to say: air, water, and land. So, here environment is neither the totality of the biosphere nor Nature, with a capital "N": the former is too broad, loosely defined, and the latter too value-loaded, to be the object of a scientific approach.

Note: The term "social optimal point (or degree) of pollution" is often used. It has almost the same meaning as "complete set of pollution standards" which would be consistent with the overall economic, social, environmental, and redistribution objectives of a society; in fact, reflecting those societal objectives whatever their relative weight.

When anything is free, there is a tendency to consume it without regard for future consequences, but with water and air, as with free love, there is a limit to the amount available to the consumer, and after a time, there is a risk of exhaustion.

M. I. Goldman, "The Convergence of Environmental Disruption." in Science, Vol. 170, 1:3953, Oct. 2, 1970.

As the earth becomes more crowded, there is no longer an "away"--one person's trash basket is another person's living place.

National Academy of Sciences, Environmental Quality and Social Behavior, Strategies for Research, 1973, p. 17.

For most people, life is pretty drab already, so why not add a little frisson to it by imagining that we are really on the brink of disaster; we can then either go down bravely in an orgy of last minute revelry or rush about busily from conference to conference urging everybody to stop the music and get down to the serious business of saving the "spaceship earth" from imminent catastrophe.

Wilfred Beckerman, Environment and Development (the Founex Report), International Conciliation, January 1972, no.586, p. 58.

Introduction*

For the last few years there has been a growing concern about the environment and, since 1973 and the "energy crisis," ideas like zero-growth and ecological balance have been widely discussed in the U.S. and then in Europe. Those ideas gained substantial political support and partial legislative recognition, especially in the U.S., where the Natural Environmental Policy Act of 1969 requires to take account of the environmental quality in any public action. Those issues became the center of discussion and controversies in the European Economic Community too, in 1972, when its then-Secretary General, Mr. Sicco Mansholt made public his ideas about zero-growth. Then, too, the legislations have begun to evolve with, among other things, the creation of a Ministry of the Environment in France, at that time.

The conference of Stockholm held by the U.N. in 1972 about the Environment officially gave international recognition to the problems raised--and showed, too, how widely different and even contradictory the positions of the different countries were.

Along with that, the increasing prices of crude oil and various raw materials raised intense concern to the question of natural resources and energy, which have been dealt with in a growing number of international conferences--in international trade legislation, the use of international natural resources (the Caracas conference in 1974), the food production (Rome, 1974), the population increase (Budapest, 1974), plus many oil related meetings (Copenhagen, 1974).

The least one can say is that there is widespread disagreement and even distrust in the international community about all these questions. In fact, the questions themselves are often ambiguously termed and the

*see bibliography, Parts IX,X, XI, XII

motivations behind many spectacular position statements are not quite clear.

To put it simply, the concerns have been put forward by the developed nations at a moment when, as a matter of coincidence, the third world is becoming more conscious of its resources potential, of its perfect right to use them in the best of its interests, and when the greater assimulative capacity of pollution of its environment is on the verge of giving it a substantial "comparative advantage" in the international trade of some polluting industrial products. It is quite normal, therefore, that the developed nations have been suspected of taking pretext of particular problems they have to impose worldwide dramatization over the danger of development and industrialization and legislative action for environmental protection in order to keep this supremacy. Their ambiguous position on the relation between natural resources, pollution, gross national product growth, population control, energy, etc. greatly helped the initial split to sharpen, the issues to be mixed, the misunderstanding to develop. The suspicion of the developing countries is indeed legitimate--when one sees for example the enormously increased profit of the oil companies and the extremist position of certain conservationist groups--but, in our opinion, it is not less true that some of the questions initially brought to the attention of the international community are legitimate ones--indeed vitally relevant issues.

Among those issues, the one we are going to discuss here is namely the increasing pollution of air, land, and water all around the world.

The present paper is aimed at providing a rationale--a consistent framework to deal with this issue. It will therefore especially address the question of (i) what is value-judgement, (ii) what depends on the specific conditions--natural and socio-politico-economic--of each country, and (iii)

what is technical matter in the whole problem of pollution, including that, though there may be differences of interest between poor and rich countries with respect to what is the optimal environmental policy within each country, it is not necessarily true that this creates any genuine conflict of interest. It is our hope that, by bringing some material of that kind into this paper, some of the further discussions on environmental pollution can be a little better focused--precisely on those issues which indeed are matter of political judgement, putting aside what is irrelevant.

In a first chapter we quickly establish the framework and main results of the classical economic theory with specific mention of the place of the environment in it. In a second one, we discuss in some detail the question of externalities (the economic significance of pollution) and how they relate to a socially determined "optimal degree of pollution." Chapter three goes at the heart of the question of measurement of costs of pollution--that is the question of how a particular society defines social welfare--which leads us to specify the relation between this "social optimum" and the economic efficiency objective. Chapter four deals primarily with the kind of policy instruments one can think of in this area. In the conclusion we put some of the results and consequences of what have been discussed which seem particularly relevant in terms of the objectives of that paper as stated earlier. Finally, in the appendix, we gathered some of the main issues concerning the relationship between environmental protection and international trade. A substantial bibliography will be found at the end. This paper has been based on two main sources: Environmental Economics, by Seneca and Taussig (Prentice-Hall, 1974) and the work of A. Kneese at resources for the future, mainly in his following article:

" Environmental Quality and International Trade," International Organization, Vol.26:2,Spring I972,found also in Resources for the Future, Reprint I02 Another source is the article "Pervasive external costs and response of society ":Resources for the Future,Reprint 80, and Management Science, Vol. I9, No I0, June I973, "management Science ,Economics and Environmental Science ". We would like to express our thanks , too, to Professor F. Eugene McJunkin who reviewed the manuscript and suggested useful corrections.

1. Social Welfare in a Private Market Economy and Its Relation to the Environment

1.1 Some Definitions

An economic good or service is anything that is scarce--i.e. the demand for it exceeds its supply at zero price. Almost all resources--which are defined as anything that contributes to making desired goods and services available for consumption--are limited relative to the desires of man to consume. Economic welfare is measured by the value of the consumption of economic goods and services over some period of time. Certainly such aggregate figures to measure welfare have been argued to be misleading. In fact welfare depends, too, on the compostion and distribution of economic goods and services. A procedure, the allocation of resources in the production process, for example, will be said economically efficient if it allows the maximum production or consumption of goods and services for any given available amount of resources.

The benefit of goods and services are their value to the consumer--and can be measured by market prices .* For the public goods, and services, that is, the goods and services for which there is no determined price (national defense, public education, recreation areas), the benefits must be inferred by some less direct method. Costs are foregone benefits from the consumption of some good or service--that is, are essentially opportunity costs. Households attempt to maximize their welfare, given their income, by buying a combination of goods and services from the firms which major goal is the maximization of profits, that is, the difference between the costs of productive services they had to hire in order to produce the desired goods and services (expenditures) and the benefits from

* Or by administrative price ,in a centrally-planned economy

their sale to the customers (revenue of firm). Firms and households interact through the market,* institution through which potential buyers and sellers exchange the input and output of the production process: firms are suppliers of consumer goods and services (output), and households are demanders—conversely, households supply the services of their labor and capital to firms (input), and firms are demanders.

1.2 General Equilibrium in a System of Private Markets

Here, we will only give briefly the results of the general equilibrium (neo-classical) economic theory—with emphasis on those which will be relevant for our discussion of the interference between the economic system and the environment.

It can be shown that, at the equilibrium, in an hypothetical system of perfectly competitive markets, given the level of technology, the tastes of the households, and the distribution of all resources among individuals, the price of all goods and services in input and output markets are determined simultaneously so that, through a complex system of iterative interactions which we won't get into here, individual households maximize their welfare and the firms, their profits. This is the state of general equilibrium. In this hypothetical system, the individual welfare depends on individual household evaluations of the consumption goods and services each is able to consume, exactly as the benefits and costs are evaluated in relation to the individuals' preferences which have been aggregated. We can therefore talk of social welfare as well as social benefits and social costs, when referring to the welfare, benefits and costs defined in this hypothetical system.

It can be shown that the General Equilibrium defines a state of economic efficiency in the whole society—that is, a state of maximum

* for non-market-economies ,see discussion on page I8

social welfare. In this state of equilibrium, it is impossible to make any readjustment of production or consumption arrangement that would make even one household better off without making some other household worse off. This state is often called a Pareto Optimum.

In the state of general equilibrium:

i. The various inputs contribute at the margin to the production of output in the proportion of their prices.

ii. Consumers are willing at the margin to give up product X for product Y in a proportion which is equal to the ration of their prices.

iii. The prices of all goods and services on the market are equal to their marginal cost of production, that is the cost of the last unit produced, and the price system provides a set of perfectly adequate signals so that all the resources of society will be allocated in the production process in an optimal way (to provide maximum welfare or utility to the consumer and maximum profits for the firms). This is why the costs and benefits computed with this perfect set of prices are called social costs and benefits. This is another way of approaching the concept of social costs and benefits: they embody somehow the notion of optimal allocation of resources. In this chapter, we consider that utility—welfare—is only constituted of the consumption of marketable goods and services sold for money in the market by firms of consumption goods—then we can legitimately use the term "social"; when, in Chapter 2, we broaden the scope of the meani of welfare, we will have to broaden the definitions of costs and benefits, if we still want to refer to social costs and benefits. We use the term "social" when costs and benefits relate to the general (social) welfare in a society, however this society chooses to define its social welfare.

1.3 The Assumptions on Which General Equilibrium Theory is Based

As important as the results of theory itself is the explicit establishment of the assumptions on which it is based. The assumptions are the following:

i. Consumers and producers are perfectly rational (that is: follow perfectly the behavioral assumption of maximization of welfare and profit). Furthermore, the utility functions are independent from one another, and income has a constant marginal utility (that is, the last dollar of his income spent by the individual brings him as much satisfaction as the first one).

ii. The market is perfect, that is, all information concerning technology, the supply and demand, related to each good and service, is fully and instantaneously transmitted to producers and consumers. There is also the assumption of perfect mobility of labor and capital.

iii. There are no monopolies, that is, a buyer or seller who has the power to affect a specific market price, which means that there is no competition. It can be shown that the monopolistic firm would produce less (and therefore at higher prices) than would competing firms—which would not lead to the most efficient equilibrium.

iv. There is a scale for the production process of each good and service at which the marginal benefit begins to decrease (law of decreasing returns to scale).

v. There is full employment of resources so that the costs and benefits are not only the social costs and benefits, but, equally, the opportunity costs and benefits.

vi. The initial distribution of wealth is considered acceptable and satisfying.

vii. All the goods and services produced as well as resources used are privately marketable, that is, provided to or taken from only those who are willing to pay or get paid for. In other words, there are no externalities involved in the production/consumption process.

Economists have long been searching for a minimal set of assumptions which are sufficient for markets to attain Pareto Optimality, and it is doubtful that the end of the search is anywhere in sight. But we will focus here only on those which are relevant to our purpose.

1.4 The Relevance of the General Equilibrium Theory Framework*

Clearly, no economy ever approached the conditions required to which the theory can strictly hold. Still, this theory provides a useful framework, even if it has many shortcomings. Furthermore, even if the General Equilibrium theory is the economic rationale of the capitalist system, it is important to see that it still provides a meaningful framework not only for the understanding of the economy of those countries where the firms are almost entirely in the hands of the private sector, like in the U.S., but also to a wide variety of countries where the public sector has a significant or even a major role in the economy (France or Italy, for example). In these cases, one uses corrected market prices, so that one gets a good approximation of the real social costs. A classical correction consists in assigning a cost lower than their money cost to all the goods and services used in a project and which would have otherwise been unemployed. But there are countries, and among them many developing countries, where the above assumptions are violated particularly strongly and pervasively; one can then value the resources, goods and services by systematic shadow prices instead of taking the market prices, which might not even exist. These shadow prices are stated in terms of their contribution to overall

*see bibliography part III

development goals of the economy, expressed in physical target-output levels, that is, these shadow prices are based on the marginal physical rate of transformation (how much unit of X should be sacrificed in order to get 1 extra unit of Y).

Finally, we can say that the chosen framework is relevant to a wide variety of politico-economic situations. We will see further that the question raised and the general problematic suggested is relevant too for centrally planned economies, although the solutions suggested should be adapted for those particular cases. Anyhow, it is clear that the kind of conceptual problems raised here—how to deal rationally with externalities—has not yet been really handled by any economic system. The solutions might differ, but the problems are the same. This means, too, that at conceptual and theoretical levels, a lot of elements are relevant independently of a specific economic syste

1.5 Introducing the Environment

We will focus on the last assumption. Basically, it says that there are no public goods or public resources. First of all, it means that goods and resources are provided to or brought from only those who are willing to pay or be paid for; and secondly, this means that each consumption and production process not affected by external production and consumption processes (independence of all production functions and independence of all utility functions). The effects which are the reason why those assumptions of independence do not hold are called external effects and are conceptually closely related to the environment, which is firstly a resource for which there is no market and which is typically a public good, and secondly the medium by which the adverse external effects are carried and transmitted.

We will now examine in some more detail the general problem of the externalities, and especially those associated with the environment. Later on, we will come back to the other assumptions which have indirect relationship with the environment or policies for environmental protection.

2. Externalities, Economic Efficiency and Environmental Management*

From now on, the terms costs, benefits, welfare, efficiency will relate to the overall social welfare as defined in a particular society, whatever it may be; we will always mean social costs, benefits, welfare and efficiency, exactly as defined in paragraph 1.2, even if we do not specify it each time. The only difference is now that this welfare might not only depend on the maximization of consumption of goods and services which are the output of firms and which you can buy with money, as it was implicitly assumed so far.

2.1 The Concept of Externality

The effect of the purchase and consumption of certain products upon persons or decision units that were no parties to the exchanges are called externalities. A first class of externalities are the pecuniary externalities- that is the change in price of a commodity which results from the individual's decision to purchase it or not. Usually the change is negligible but not always; theoretically, those externalties are not a problem and do not concern us here. A second class of externalities are the technological externalities. Typical of such externalities are the noxious smoke and polluted water emissions of modern industrial plants. If we suppose that there is no smoke-control legislation, a steel manufacturer, for example, will choose the method of production which is most profitable without regard for the associated level of smoke discharge since there is no motivation to limit the use of the resource which might be called smoke disposal. But, although the discharge of smoke can be viewed as a free resource by the firm, it is certainly not so for those residing in the neighboring communities, which will bear the extra costs of cleaning, maintenance and repair of buidings, and, probably too, of increased health problems, which we can call the external costs (external to the firm) because they

*see bibliography, Parts I, III, and IV

are imposed on society, outside the market system and are not reflected in relative market prices. Furthermore, this smoke may kill the birds that people of this community used to hunt, and some of these birds might be very rare species of birds which some people are holding as very precious. All these are real costs to this community, even though all these costs are not directly computable in dollars (we will come back later to this problem). In other words, to the community at large, the discharge of smoke into the atmosphere is not a free resource, and the steel manufacturer does not bear the full cost of his actions. The social cost of producing steel defined previously (or: opportunity costs), which lead to the optimal allocation of resources, is the sum of the private cost--actually born by the steel manufacturer--plus certain external costs, which, in our example, he does not bear. There is an almost infinite number of examples of this kind one can give, in the fields of air and water pollution, land and landscape degradation, and so forth. There are similarly, external benefits, which can be denoted as desired external effects.

We can define now better what are those characteristics of the environment which put it at the heart of the external costs question.

i. The environment has an economic value, for example by providing waste disposal resources.

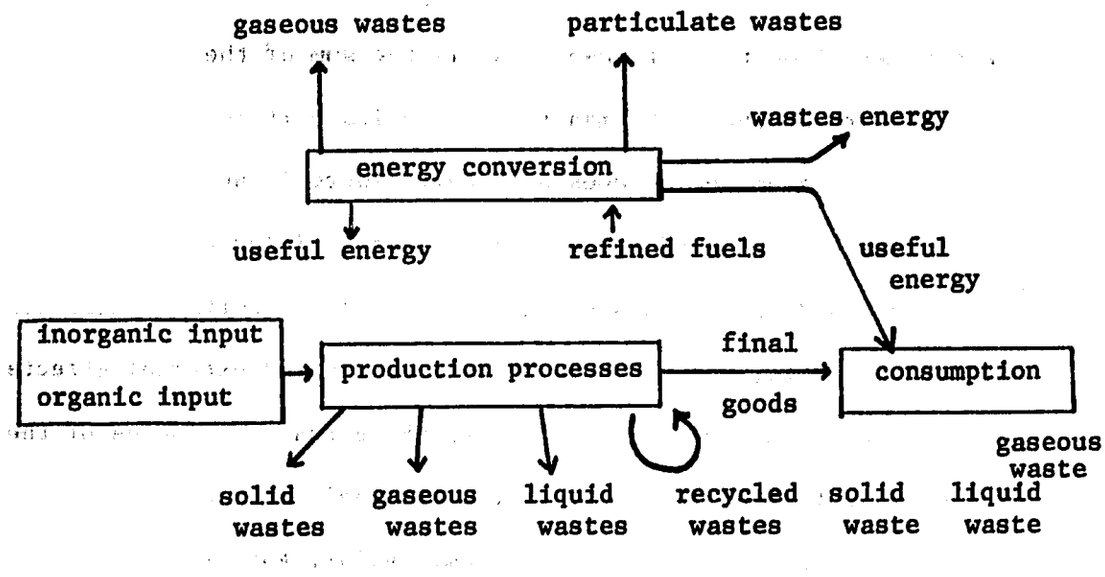
ii. It cannot be reduced to individual ownership and does not enter the market.

iii. There are patterns of use of the environment which may impair its value, and therefore, cause external costs.

2.2 The Pervasiveness of Externalities

Because physical matter cannot be destroyed, the final output of

the economy, after they have been consumed (that is, after their services are utilized) also reappear in various waste-form in the environment. The laws of conservation of matter and energy tell us that these residual wastes will be virtually identical in amount to the physical masses of all the inputs. As the waste is often discharged in the environment without anything charged for the value of that resource input to the production process, external costs are often associated with waste disposal. A scarce good (waste disposal) is used at zero price at the expense of the rest of society.



the Flow of Materials

Some wastes may be recycled into the production process as inputs, others may be reconverted in input through natural biological processes; the distribution of the residual wastes among the various forms (liquid, solid, gas) is largely defined by society—this being the problem of efficient waste disposal.

To review the points briefly:

i. Technological external diseconomies are an inherent and normal part of production and consumption. These diseconomies are opportunity costs for the society--that are "real" costs of foregone benefits.

ii. They become progressively more important as the population rises and the level of output increases.

iii. They cannot be properly dealt with by considering environmental media such as air and water in isolation from each other.

It is important to note that even if a particular type of production activity does not directly utilize inputs from the environmental sector, it may do so indirectly through its demands for intermediate products from sectors that do. In fact, it is difficult to imagine any economic activity which does not directly or indirectly contribute to demands on the unpriced environmental sector. And if this is true, a nearly universal divergence between prices and social costs is implied. Let us specify again what we really mean in this paper by costs, because it is at that point that lie many potential misunderstandings. A cost is anything that has an adverse effect on social welfare as defined by a particular society through its institutions. The most simple costs to handle are of course the money costs--which are basically opportunities of marketed production and consumption foregone. There are also costs which cannot be directly translated to money costs, corresponding to things one cannot buy with money in the market, and which depend very much on the value system of an individual or a society, like the cost of the disparition of all whales from the earth. For some societies this cost will just be zero but not for others; in other words, the presence of whales on the earth will be included in the social welfare function of some societies, and not in some others. And among those which include it, the degree at which they are included is variable. Nonetheless, in a general

theoretical discussion of costs, we cannot decide "a priori" to exclude them. We will see in part 3 that the political process determines the value to give to these costs, but conceptually it is very important to make the difference between a cost which a society decides not to consider (or consider as inexistent, or null) and a cost which never exists. Between these two extremes, there is a continuous spectrum of types of costs (see paragraph 3.1).

The existence of those pervasive externalities has led economists like A. V. Kneese and R. D. d'Arge to write:

> We see an urgent need to develop more relevant and operational economic models for dealing with pervasive externality phenomena. A few economists have observed that external diseconomies increase rapidly (nonlinearly) and pervasively with economic and population growth, but comparatively little has been done to formulate analytical or normative models based on this insight . . . In our opinion, economic theorists face no more urgent task than to devise improved models for the analysis of environmental pollution, urban congestion, landscape deterioration, and the host of other externality phenomena which accompany economic growth.

But, even without these new economic models which are called for, we still can replace the externality phenomenon in the General Equilibrium framework, in order to analyze the precise economic meaning of this important departure from the basic assumptions on which the General Equilibrium model rests.

2.3 The Economics of Externalities

The economic effect of an externality can best be illustrated by an example; let us assume that a farmer grows corn and irrigates his land with the water of the nearby river, and that the corn yield is sufficient to keep the land and the farmer from turning to alternative production. Let us assume a paper mill is built upstream, degrades the water quality to a point that lessens the productivity for the farmer downstream. Let us

assume, too, that the polluted water has an effect only on the crop of the farmer, and on nothing else; the net social gain from the paper production is equal to the excess of the value of the paper over the values of the factors of production in their best alternative uses (net benefit of the paper mill, in the General Equilibrium framework). The external diseconomy of paper production is measured by the farmer's net income loss. The net social gain of the partial or total substitution from corn to paper production is not necessarily greater than zero. We see here that externalities can lead to make decisions which result in net social loss.

More specifically, a firm which operates on the basis of its private costs and not of the social costs (like in the example of the paper mill) will not make an optimal allocation of resources, from the point of view of the whole economy.

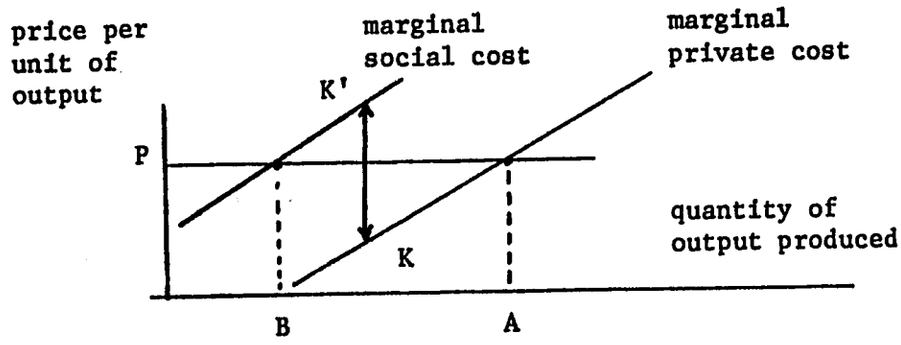


Figure 1: Equilibrium of the firm reconsidered

In the General Equilibrium theory, a firm produces up to the point where its marginal cost of production is equal to the prevailing price of the good on the market. In our example, the firm would produce a quantity OA of paper (see figure 1). But, if the external costs inferred per unit of output is KK', we see that the really optimal policy

would be to produce only a quantity OB of paper, because the inputs used to produce the additional BA quantity of paper would have a better alternative use elsewhere in the economy.

Let us now take all the paper mills altogether, supposing they all cause the same degree of external diseconomies.

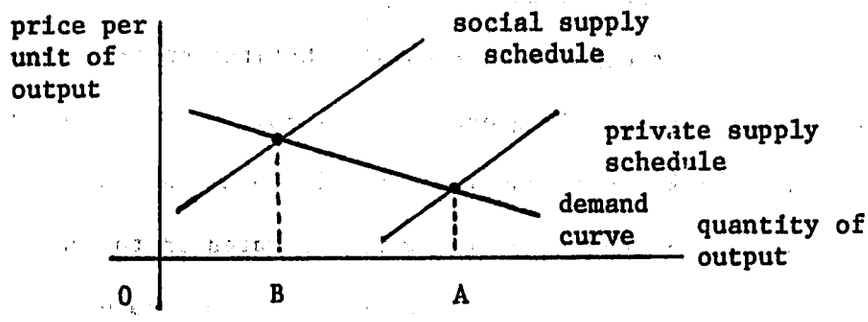


Figure 2: Equilibrium of the industry reconsidered

The private (respectively: social) supply schedule here indicates the quantity of output which would be produced by the industry for each level of market price, if the industry takes the private (respectively: social) costs of its production into consideration (see Figure 2).

We see here that the paper industry would produce more paper and at a lower price than socially desirable—the resource allocation is not optimal, the costs of paper does not reflect its true opportunity cost for society, and it would have been socially more efficient to use somewhere else the resources used to produce the extra BA amount of paper.

The existence of externalities leads rational decision makers to misallocate the resources because the costs computed are the private costs, not the social costs or opportunity costs, and therefore give misleading indications on what ought to be produced, at what price, in what quantities.

2.4 The Social Optimal Degree of Pollution Concept

Let us now suppose that we can compute the cost of pollution (cost as defined in paragraph 2.2); this is to say, the benefit to society of each "unit of pollution" removed. We will discuss later, in paragraph 3.2 the problems involved with the measure of those social costs and benefits. Let us suppose, too, that we can compute the cost of treatment for each degree of environmental purity.

Following with our example of the paper mill, let us furthermore suppose that the social benefit for society (or the downstream farmer in our example) is proportional to the number of "units of pollution" removed from the river and that the marginal cost of treatment increases linearly (see Figure 3).

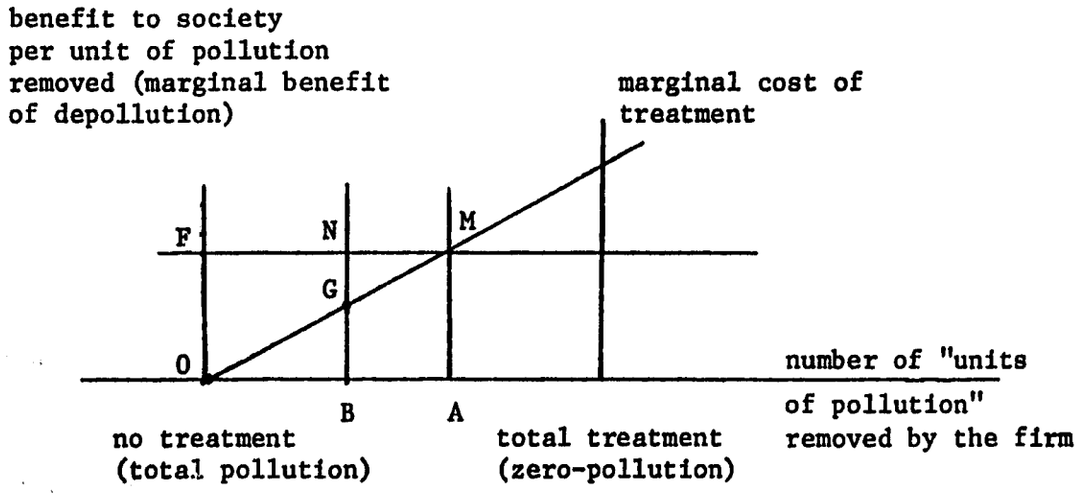


Figure 3: The socially optimal degree of waste-water treatment for a firm

In Figure 3, we see that if the paper mill removes OB units of pollution, it will cost it a price represented by the surface OBG, and the benefit for society will be represented by the surface OBFN. It

follows easily that the degree of depollution such as the difference between benefits and costs of depollution is maximum, is at point A, where the marginal cost of treatment is equal to the marginal benefit of treatment. In other words, the most efficient policy would be to remove OA "units of pollution" and leave the rest of it.

We can generalize this result for the whole economic system, and draw the benefits and cost curves of depollution (see Figure 4).

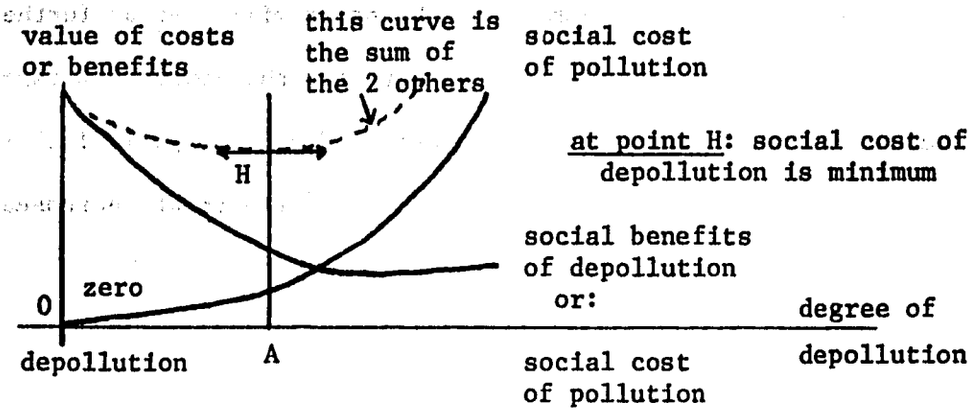


Figure 4: The socially optimal degree of pollution (or depollution)

The social optimal point of depollution will be such as the total costs are minimized. It can be shown that this approach gives exactly the same results as the previous one. If costs are defined as in paragraph 2.2, this optimal point of pollution will reflect all that that society values--in other words, it will be consistent with its definition of social welfare. If a society decides to count as costs only the direct money costs, the social optimum point of pollution corresponding to that society will, too, correspond to its definition of social welfare, which would be just to minimize immediate expenditure (we will see later that this does not correspond to maximum economic efficiency). Therefore, the

goal of any consistent policy would be to induce the firms to depollute until point A, at a supplementary cost which would represent the external cost. Thus, this external cost would be "internalized" by the firm, adding it to its private cost in order to make its decisions now with the real social costs of production, which would theoretically remove an important cause of non-efficient allocation of resources in the economy. An optimal solution in fact means some deterioration of environmental quality, because there is no reason why point A should be at zero-pollution level.

2.5 The Theoretical Solution to Reach the Point of Social Optimal Pollution

The problem is to find some means of achieving a socially efficient resource allocation in the presence of externalities. We have seen in 2.4 that social efficiency, in our General Equilibrium framework, requires that each firm depollutes its residuals up to a point where the marginal cost of depollution (cost of depollution of the next higher degree) is equal to the marginal social benefit of that depollution (marginal social cost of pollution). Therefore, the solution consists in inducing firms to internalize the external effects of their production activities so that they make decisions which include the real social cost of their waste disposal--in other words: socially optimal decisions. In order to reach this previously defined optimal depollution point there are two solutions:

- The firm can be charged at the rate equal to the marginal social cost of the pollution it causes--per unit of pollution imposed.
- The firm can be paid at a rate equal to the marginal social benefit of the depollution made--per unit of depollution achieved.

These two solutions are conceptually identical--the practical aspects will be reviewed in paragraph 4.2. Their consequences are far reaching, potentially: as we have seen, there will be a shift in the resource allocation in the production process from non-optimal to optimal, changes in prices, consequently changes in the total output of the economy favoring the goods and services which involve the smaller externalities and, in the longer run, the development of technologies which otherwise would not have been considered ("soft" technologies).

As in paragraph 1.4 we can say here that even though there are some politico-economic contexts in which the basic assumptions of our framework do not hold at all, one can make two remarks:

1. As argued in paragraph 1.4 it is not fundamental for the whole externality question that the prices are determined by the free market, as long as there is a relative value of all commodities in terms of production goals and production opportunities foregone.

2. Whatever the way prices and values are derived, the question of this higher degree of social and economic rationality meant by the inclusion of externalities in the rationale of the decision making process, has similar conceptual characteristics, and addresses itself to the same kind of problems--even though the practical policies considered as solutions might of course differ.

3. The Measure of Costs and Benefits Associated with the Environment*

So far, we have taken for granted the various social benefits and costs related to the environment to draw the curves of Chapter 2, in order to concentrate on the conceptual and theoretical aspects of the problem. But in fact, the measure of social costs and benefits is much more than a technical problem, because we defined them in relation to the overall social welfare. What are exactly the elements to include in the computation of social costs and benefits is to a certain extent a value judgement because the definition of social welfare varies from society to society. In this chapter, we will differentiate the various types of costs associated with the environment, and then classify those costs into categories, from the least to the most subject to value judgement when measured.

We will not refer to benefits in this chapter, because we will consider them as negative costs.

3.1 Des-aggregation of Social Costs in Components Characterized by a Type of Measurement and Type of Cost

We will define a first way of breaking down into elements the social costs associated with the environment (paragraph 3.1.1) which we will call the "measurement type" axis, or the "monetary vs. non-monetary" axis. Then we will define another way of breaking down the social costs associated with the environment into elements (paragraph 3.1.2), which we will call the "pollution vs. de-pollution costs" axis. Finally, we will desegregate the social costs according to both axes at the same time (paragraph 3.1.3).

3.1.1 The "measurement-type" or monetary vs. non-monetary" Axis

i. Certain goods and services are marketable. Following

*see bibliography Part II and VII

our initial assumptions, their value will be their market value, in dollars. (They are sometimes called consumption goods.)

Others are non-marketed or non-marketable but divisible and measurable, like the provision of recreation facilities. Various methods, like the willingness to pay method, permits the estimation of money valued benefits for that type of goods and services.

Others are measurable public goods and services--that is, if provision of the goods and services is given to an individual it is then necessarily given to a group of individuals, possibly the whole nation. Clear air is an example. The measure which characterizes the goods or services exists but it is not in dollar terms. We include here the costs of disparition of rare species, increased ecological instability, aesthetic losses, etc.

We will call those measurement types of goods and services measurement type I, 2, and 3. Their value is increasingly difficult to assess, from type I to 3, with less and less firm criteria for objective decision on an evaluation, as measurement of the cost. In other words, from measurement type I to 3, the differences in the definitions of social-welfare from one society to another has more and more impact on the measure of the cost of the related element, or component i.e. the social cost associated to the pollution of the environment.

3.I.2 <u>The pollution vs. depollution costs axis</u>

We can break down the social costs associated with the environment in the following way :

Pollution prevention costs (represented by the curve called "costs of depollution," in Figure 4), which are the costs incurred to prevent partially or entirely the pollution that would otherwise result from some consumption of production activity. These costs are usually easily computable in dollar terms since the goods and services involved are exchanged in the market. These costs have many secondary effects, like pecuniary externalities (changes in prices, etc.), and input on the distribution of income, which is to be taken into account later. In the line with changes in prices, due to the costs of depollution one must mal a distinction: if we analyze the present state of a country, those changes in prices have already occurred and are irrelevant now. But, if we imagine a dynamic situation--for example, if we try to evaluate the cost of new standards of pollution in a country, we would have here not only to count the costs of the technological devices used, but the non-monetary costs induced by the fact that maybe some firms would go out of business (unemployment, etc.). As we saw in paragraph 2.4, prices of some products would rise, which would affect segments of the population. This, too, would have to be included.

Pollution costs which can be broken down in (i) the expenditure undertaken to avoid pollution damage once pollution has already occurred: those costs are municipal building cleaning, individual protection from noise, additional water treatment. Those costs are linked to goods and services from valuation type 1 to 3, and involve, too, significant distributional effects. The other aspect of pollution costs are (ii) the welfare damages of pollution, from direct costs to other users or producers, to recreational and aesthetic losses. They are derived from

goods and services of valuation type 1 to 3, that is, include costs that are uncertain, long term, subtle and complex to establish.

The sum of those costs is the "costs of pollution" curve on Figure 4.

3.1.3 Desegregation per type of measurement and per type of cost

type of measurement axis → / ↓	marketable (consumption goods) meas. type #1	non-marketable divisible prices meas. type #2	non-marketable measurable public good meas. type #3
pollution prevention costs	treatment costs anti-pollution devices	unemployment change [in dynamic situation only]	
costs of avoidance of pollution damage	individual protection devices		migration of people to the suburb
cost of pollution	damages to crops health hazards economic cost	recreation opportunity losses	aesthetics psychologic ecologic damages
	direct $ measure by economic process	indirect $ measurement; economic and political process	measure through political process

3.2 Introducing the Multiple Objective Welfare Function

We see that for all those costs of measurement type 1 there should not be too many measurement problems. For costs like loss of recreational opportunities, there will be large differences among societies, but they can still be measured in dollars. For type 3, the measure in dollar terms is almost impossible. In that case, it is better not to try to segregate those costs by a priori dollar value, because that leads to submerge the real issues behind a facade of faulty measurements. We keep these costs separated, to confront the choice of measures open and explicit. In other

words, we recognize our impossibility to translate those elements of the total costs of environmental pollution into dollars. They are part of the total cost, relative to a society's definition of social welfare, but they cannot be accounted for in dollars. We will count them separately, with other units of measurements. These costs, of measurement type 3, are grouped in a few broad categories. Each category corresponds to one type of unit of measurement, for example, some kind of ecological scale,* some kind of social well-being scale. Each scale refers to an objective, which was previously hidden in the overall social welfare function. Let us stress here that a cost in the ecological sector, but which could have been measured in dollars would not appear under the ecological scale, but the dollar scale. The entire set of these objectives and their relative importance is the way this particular society defines its social welfare. (see Figure 5) The multiple objective problem exists because of limitation in our techniques for assigning values. The multiple objective problem is a valuation problem.

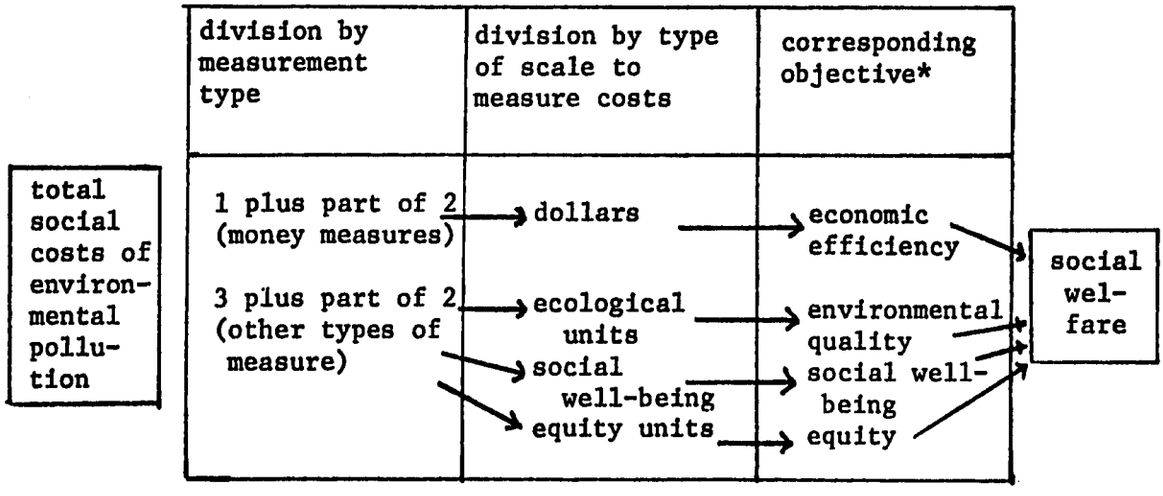


Figure 5: Social costs as they relate to social welfare through a multiple objective function which solves the measurement problem

We gave to the objectives their traditional names, but this might be misleading. For example, environmental quality here, refers only to those ecological elements which are not measured in $.

The social costs of environmental pollution is therefore the sum of all those elementary costs, each one measured along its specific scale. How this sum is made, is what we examine next.

3.3 The Process of Determination of the Social Optimal Degree of Pollution*

The final cost assessment, which requires a relative weighing of the objectives, appraisal of the trade-offs, can only be done through the political process. We will not address ourselves here to the question of the ability of the political process to articulate unambiguously and coherently the conflicting patterns of individuals' preferences and wishes. But this problem has given rise to a whole body of knowledge, and the English economist K. Arrow won the Nobel Prize for his work in this area.

We do not say here that actually the political process, when debating for example about an anti-pollution legislation, formally discusses the weights of objectives and importance of the trade-offs. But indirectly, these are the issues, even if not explicitly mentioned.

At this point, therefore, an hypothetical rational society has determined its socially optimal pollution point after having computed the various costs functions through the channels of economic analysis and political negotiations--optimal point which can be seen as a complete set of pollution standards. The ultimate task is to design the policies and procedures best adapted to bring the society to those standards. This is the object of Chapter 4. But before, let us investigate closer one key aspect of our socially optimum (efficient) pollution point: what is the relation between the social efficiency point and the economic efficient pollution point?

*see bibliography Part III
*see Appendix B

3.4 In Search of the Economically Efficient Degree of Pollution

We are interested now in maximizing economic welfare; that is, the welfare derived from the consumption of the goods and services which have an economic value--a direct money value, or we are interested in maximizing the production of consumption goods. Therefore, we will look for the pollution point determined by our two cost curves, but they will be computed only with the costs of measurement type 1--the dollar costs. Now, are considered as costs only the costs which are actually, in reality, paid in dollars, by someone in society. A society which would be at the pollution degree found this way would maximize its revenue in dollars. But this point is not as simple to find as it may seem for two reasons:

i. Those dollar costs are all the dollar costs attributable to pollution, not only those spent directly for pollution: if fishermen take less fish because a river is polluted, this is a dollar cost. If somebody gets sick because of air pollution and goes to the hospital, this is a dollar cost. Of course, if the person did not go to the hospital, and was previously unemployed, this sickness would be of zero dollar cost. But still, we have to take account of all dollar costs to be consistent. Furthermore, if a firm is obliged to pay an effluent tax to meet the economically efficient degree of pollution and gets out of business, this will not be considered as a loss: it would show that the resources formerl used by this firm would be more efficiently used elsewhere in the economy. This would be a zero dollar cost operation.

In short, the task of measuring the dollar costs, only them, but all of them, is complex enough to give room, in fact to some value judgement (where do you stop in measuring secondary, tertiary costs?). But, it is

important to note that the cost curve found would be higher in scale than the one our present state of pollution assumes, in many countries, because really only a very small part of the dollar costs are at the moment considered. The other costs exist, are paid by society, but are forgotten when one calculates the cost of pollution. Therefore, the economically efficient point of pollution is a less polluted point than the actual one, even in many developing countries.

ii. The other problem rises with long term considerations. For sure, for example, the pollution of the oceans has not resulted in dollar costs, except in very special cases. But in the long run? Are we not short-sighted, so that one day, we will discover that we are faced with catastrophic ecological problems, not thought of before, not valued in economic terms, but which result in catastrophic economic losses suddenly? Are we sure we value economically all that we should in a process like the one described in i ? --(which would already take into account much more than is actually taken). In the short run, the answer is "yes"--But in the longer run?

In conclusion, we see here a sort of continuum between the dollar measures and some of the others: some of the non-dollar measures have an economic value, if one looks a little farther ahead in time. But, the distance you look ahead is, too, very much a value-choice, which every society makes for itself. Therefore, even the concept of economic efficiency is not so clear-cut as it may seem, and its definition may vary from one society to another, according to accuracy of the dollar-costs one can get, and to the time-horizon one chooses. We will see in the conclusion other reasons why the optimal point of pollution varies from society to society.

4. Policies Instruments of Allocations of Environmental Costs*

4.1 Aiming at the "Second Best" Instead of the Optimum

It is not presumed that any policy instrument would achieve complete correction for all deviations from the socially optimum point. What we look for, in reality, is a partial removal of deviations between social and private costs for environmental services--in other words--we look for a "second best" point. For simplicity of exposition, we will continue to talk of the "social optimum." The goal is now clear: to reach the point of socially optimum degree of pollution, socially meaning that this point is coherent with the overall objectives of that society, whatever these objectives may be. It can very well be only the economic efficiency objective. In that case, the social optimum is the same as the economic optimum. But, to reach that point, there are several types of policies instrument possible, which are theoretically equivalent. The question is to choose among them the one which, in practice, is the best suited. The fundamental idea is that a policy instrument will bring us towards the optimal point by allocating "well" the social costs of pollution. To evaluate the accuracy of an environmental management and control policy instrument, one has always to refer to the concrete cases at which it is directed. It depends whether the policy is aimed at internalizing externalities between two producers, or producers and consumers, or between consumers themselves. In the first two cases, it will depend, too, on the number of producers involved. The policy instrument, too, will depend on the degree of centralization of the economy, and the administration, depend on the fact whether the external effects considered are reversible or irreversible; therefore, here again, there is not just one solution. In the next paragraph, we will review some possible policy instruments and

see bibliography, Parts II and IV

shortly comment on each of them.

4.2 The Allocation of Environmental Costs

4.2.1 The market solution

There is a motivation for a private party to act to bribe the creator of an externality to decrease or discontinue its harmful activity. If the bargaining is perfect, the briber will propose to bid up his bribe as long as the bribe needed to induce the externality creator to reduce its discharge is less than the damage inflicted. This leads theoretically to the point of optimum pollution. But, this solution is possible only if:

i. The two parties can effectively meet.

ii. The two parties have roughly the same power.

iii. The two parties are of sufficient rationality and good faith.

iv. The damages can be evaluated easily.

4.2.2 The regulation solution. The problems of environmental quality standards

This solution supposes the existence of a governmental environmental protection commission whose first task would be to determine, through economic analysis and the political process (cf. paragraph 3.3), the optimal pollution point of that particular society. This point determines the relevant environmental standards for air, water and land quality. Thus the Agency should determine the relationship between current emission flows of any pollutant and the equilibrium level of that pollutant in the environment, and then determine how to allocate the necessary total pollution reduction among the different demanders for waste disposal in the various media in the target area, which is indeed a difficult task,

involving a lot of arbitrary. There is the possibility to force each pol polluter to reduce its pollution by a certain percentage. But this is an inequitable solution because the marginal cost of reducing the pollution is certainly widely different from one polluter to the other . But to force differential pollution reduction will raise endless problems ,under alleged inequity of differential standards . This type of solution is not flexible enough to bring optimality (cars' emission control devices are not neededin rural areas, for example) and would require regular inspection of all pollution prevention devices to make sure of the working order because the polluters have no incentive to do it themselves.

4.2.3. Solution by prohibition

This is a solution only for those pollutants having quasi infinite damage potential or which threaten the entire ecological balance supporting human life, like nuclear wastes, DDT or Mercury, that is , the pollutants for which the optimal point is zero level of presence in the environment.

4.2.4. Solution by taxation and effluent changes

A policy of effluent charges is the establishment of property rights as air and water resources ,and determines the price that must be paid for their use. It creates an incentive to the firm to evaluate the alternative costs associated with avoiding the tax, to adopt the minimum cost solution which may involve a combination of waste treatment,output, reduction,and payment of the effluent charge as we

have seen, the effluent charges per unit should be equal to the marginal cost of pollution for society at the optimal point. As at that point, it is equal to the marginal cost of pollution reduction, the firm will be induced to reduce its pollution until that point, and pay the effluent charge for its remaining pollution.

This solution is the one most often endorsed by economists but bears the danger of hitting strongly the functioning of the economy because, here again, if an across-the-board policy is adopted, some firms will have very high costs of effluent charges, even if they behave rationally.

Strictly speaking, there should be a differential effluent charge embodying the geographic differences in the social costs of effluents. Rural areas discharge fees should be lower than already relatively polluted regions. But this policy is politically and administratively difficult to implement.

4.2.5 Solution by Subsidies

This solution is similar to the previous one except that instead of being taxed per unit of pollution discharge, the firm is paid by unit of pollution removed. But such a policy can be distorted by firms going into the waste-making business, and being subsidized to close down. The other main difference is the distributional effect: here the cost of pollution reduction is borne by all taxpayers whereas previously it was directly borne by the firm and therefore by their customers.

4.3 Criteria for Evaluation of These Policies

Even though, theoretically, these proposed solutions have the same effect—to bring society to its optimal pollution point—they in fact are not equivalent and ought to be evaluated upon the various criteria on which they differ.

- Distributional impact. Who bears the costs of the internalized externalities? The objective of equity is here in consideration.*
- Administration feasibility. Some solutions are more easily enforceable than others. The overall problem is in fact to minimize the total costs of pollution, pollution prevention and enforcement.
- Incentive they provide for technological improvement. This is important because for a given society, all things being equal, the more efficient in antipollution technology, the cleaner will be its optimal pollution point.
- Comprehensiveness of the policy. Society is not any better off if all waste water residuals are discharged in the air instead.
- Flexibility of application. The more adaptable the policy can be to the geographical difference in social costs of pollution, and the polluters' marginal cost of pollution reduction, the closer it can bring society to its optimal pollution point.
- Amount of information it needs to be determined

see bibliography Part VI

Conclusions

1. There exists in all societies an overall social optimum point of ollution which has no reason to be reached by chance-- "Optimum" point n terms of the overall objectives of that society.

2. This point is determined partially by pure value judgment (determining the acceptable trade-offs between objectives not measurable in ollars and dollar costs) and therefore can neither be imposed by some ountries upon others on the ground of economic rationality nor of any ationality.*

3. Given the lack of knowledge about the long-term effects of the socio-economic systems on the environment, it may well be that this optimal point determined by the political and economic system is still, in the long run, threatening the ecosystem's equilibrium.**

4. There are no more reasons why any society should be at the pollution point which would be optimal in terms of only the first objective, that is, only the dollar measurable pollution costs and benefits (economically optimum point). Actually, the present degree of pollution in all societies corresponds to a point which embodies a part of the dollar measurable costs and benefits, and unclearly determined parts of the other objectives.

5. The economically optimum point of pollution is, too, value loaded: it simply gives a zero weight to all non-dollar-measurable elements. Therefore, there is no rationale why international legislation should be based on that either. There is no "value-free" determination of the optimum.

* see bibliography part III

** see bibliography part XI and XII

6. This optimal pollution point is also dependent on the available antipollution technology, the relative costs of factors of production, the value of outputs, and the assimilative capacity of the environment of the country (that is, the amount of pollution the environment can absorb at zero social cost).

7. Even the economically optimum point of pollution would therefore be different from a country to another. This is even more so since the economic optimum depends on the chosen time horizon.

8. It is almost certain that all countries are at a point of pollution which is higher than the economically optimum, and that the departure from that point increases with time.

9. Countries impose external costs on each other and therefore misallocate their resources at the earth's level. The reasons this paper has exposed which urge for national legislation for internalizing the external costs are valid exactly similarly at International level.

10. So, exactly as for a country, the International community will have to go through its own "international political process" to determine the relevant international standards and find, for that matter, an agreement on some overall weighing of the objectives. Even if only the economic optimum would be taken in consideration, there would still be a need for international legislation and negotiation in order to be efficient in those terms.*

11. The kind of policies designed to implement move towards the optimal point imply value-judgments too. It means that this step, too, will have to be decided through some international political process.

* see bibliography part X, XI, and XII

12. Finally, it is hoped that, if anything, this paper has shown that the first--and possibly only--thing on which there is no possible discussion, is precisely that, in any case, there is a need for national and international policy and legislation making because presently, man's use and management of his environment is totally inconsistent with its objectives, whatever these objectives are, for a simple reason: there is no linkage between the two.

APPENDIX A

International Trade, Developing Countries and Pollution

1. Introduction

During the past few years, there has been a growing concern, in the developed countries, and especially in the United States, about the environment, and more specifically about pollution. The classical answer to that problem is the "internalization of the externalities" by the principle of "the polluter pays." Given the partially subjective appreciation of what is an acceptable level of pollution (or: what is the cost of pollution), there are, therefore, theoretically, differcnt "efficient" levels of pollution for different countries (and different income groups in each country, but we will not discuss that aspect here). Those "efficient" levels of pollution, which we will call "optimal pollution point" are different for another reason, an objective one, which is the differential assimilative capacities of the environment of different countries, for example Holland vs. the Amazon region.

The recognition of the necessity of the factor of production which we could call "waste disposal," in some developed countries, has potentially very important international trade implications, and therefore implications for the development of third world nations, because the recognition of different "optimal point of pollution" for different countries, developing countries having generally a higher optimal level of pollution, is the recognition of a new "comparative advantage" for those developing nations. This recognition has been called the theory of "pollution havens"—This position is, of course, strongly opposed by developed countries, on the grounds of ecology and equity (why should the Indians of the Amazon breathe more SO_2 than we do?). Actually, the draft text of the U.S. Advisory Committee for the final resolution of the U.N. conference on the human environment held in Stockholm in

June 1972 developed "the principle opposing the exploitation of pollution havens"[1], point which has been challenged by a panel of experts advising the Secretary General of that same conference, which concluded that "environmental standards and costs are likely to be quite different in the developed and developing world, so that developing countries may still possess a comparative advantage in some of these (polluting) industries."[2] As a matter of fact, the new Brazilian plan for the development of the Amazon region is described as stating that "the objective is (. . .) to attract large firms in order to get the best of the "comparative advantages" of the forest (. . .)."[3]

Various international conferences have studied the implications of the recognition of the finiteness of natural resources in terms of international legislation for the exploitation of the oceans (Caracas, 1974), energy (Copenhagen, 1973), population (Budapest, 1974), trade agreements (GATT), or food supply (Rome, 1974), and, in each case, irreconcilable positions between developed countries and developing countries have appeared (so far, the input of socialist countries has been relatively minor, except in Budapest). Undoubtedly different theories of development, of relationships between developed and developing nations, of the appraisal of ecological disequilibrium, are in confrontation.

As the Founex report puts it "inevitably the environmental concern will cast its shadow on all international economic relations, and one can

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[1] Report of the Secretary of State's advisory committee on the 1972 U.N. conference on the human environment, Stockholm and Beyond, U.S. Government Printing Office, Washington D.C., p. 118.

[2] Environment and Development (the Founex report), published by the Carnegie Endowment for International Peace, Jan. 1972, No. 586, p. 32.

[3] Charles Vanhecke, "Le gouvernement lance un nouveau plan de mise en valeur de l'Amazonie, Le Monde, 10-11, Nov. 74.

perceive these implications only a little dimly at this stage."[4] Let us still try to look at some of these implications, the trade implications.

Trade Implications

2.1 The Two Positions in Presence

As we have seen, very broadly speaking, the position of the developed countries is to call for some kind of international pollution and environmental standards, considering it is the interest of all nations to protect the environment, and that it is just fair no one can profit by having less stringent environmental standards to become more competitive on the world market. There is a correlation between pollution and the rate of growth.[5] On the other hand, developing countries do support the notion of "pollution havens" and the notion of the fairness of the comparative advantage they would enjoy, given their less high environmental standards resulting in a different trade-off between economic growth and environmental quality and a better assimilative capacity of their still relatively unpolluted environment—arguing that their only real environmental problem is the one of poor water supply, deficient nutrition, bad housing conditions, sickness and disease. They argue their comparative advantage is "exactly as fair as the one France has to produce wine and the U.S. to produce wheat and computers."[5]

2.2 General Effects of the Settling of Environmental Standards in Developed Countries

In general terms, the problem is to "internalize the externalities" created by pollution; it is possible to achieve that, either to subsidize

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[5] The Founex Report, op. cit., p. 27.

[4] Nake M. Kamrang, "Economic Growth and Environmental Impact," Socio-Economic Planification Science, Vol. 7, pp. 37-53, Pergamon Press.

the firms for each unit of pollution removed, or to tax them for each unit of pollution left. In fact, the repercussions are very different if one chooses one of the other policies, as shown in the next paragraph, which was inspired by Kneese and d'Arge.[6]

The discussion taxes vs. subsidies shows that the subsidy policy to meet environmental standards would result in the long run in accumulative misallocation of resources, thus threatening global efficiency, exactly as tariffs barriers opposing international trade would do, because the private costs would systematically differ from the social costs, becoming distorted prices and cost signals. Anyway, whatever the policy, it will deeply affect international trade which will be partly determined by each country's preference for environmental quality and Environmental Assimilative Capacity. Efficient world-wide allocation of resources requires that the social cost of an export product, including environmental taxes, should be reflected by export prices, even if the taxes are widely different from country to country due to different optimal pollution point.

The effects of a specific policy will depend, too, whether the good produces externalities when being produced or being consumed, if the export industry produces under conditions of increasing, decreasing or constant costs per unit of product, if the elasticity of demand for the product is greater or not than one: in short, there is not a simple one-to-one correspondence between pollution control costs and changes in export prices. Nor is there a one-to-one relationship between changes in export prices and evolution of the export with time.

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[6] A. V. Kneese and R. C. d'Arge, "Environmental Quality and International Trade," International Organization, Vol. 26:2, Spring 72.

2.3 Effects of Environmental Standards on Developing Countries

An important aspect of the question discussed here is that, even if only developed countries set environmental or pollution standards, this might do much harm to developing countries, along the following lines, which can partly be deduced from the previous paragraph:

i. Those goods which produce pollution while they are fabricated (as opposition to those who pollute during or after consumption) will be sold at higher prices.

ii. Some goods exported by developing countries might be prohibited on the ground of environmental standards (for example, traces of DDT in agricultural products). And these standards can be sometimes seen as non-tariff barriers, like in the following example: Germany has restricted the lead content of gasoline to 0.15 grams per liter. German vehicles can easily be adjusted to low-lead gasoline, but several major Italian and French automobile makers' high compression engines cannot be so easily adjusted. Is this a non-tariff barrier?

iii. Some fear that aid might be reduced, as the high environmental standards in developed countries might induce governments to subsidize some of their national industries, or that design and approval of projects financed by international or bilateral aid would be much longer and difficult.

iv. The technologies which would appear in developed countries would not be really suited for developing nations: machines would generate less pollution but would cost more, which is not what developing nations look for. Furthermore, all the technology of depollution will have to be imported, without a possibility of a "multiplier effect," thus increasing the dependency.

3. Conclusions

R. C. d'Arge and A. V. Kneese argue that, for the U.S., the effects

of reflecting true social costs in export prices would not globally affect the international trade of that country, but would affect certainly heavily some specific industries (paper mills, for example).[7] Such studies have not been systematically done for all countries, so that it is still difficult to assess what are the trade-offs involved between the balance of payments' situation and environmental quality—which indeed would be a major indication for a country to decide its optimal social pollution point. On the side of developing nations, the effects are still much more uncertain; this of course exacerbates the debate over international trade and specifically environmental legislation at international level, since "just as with disarmament, perhaps even to a greater extent, the dynamic of competition leads to an endless search for relative advantage"[8]—and precisely, it is a new distribution of the comparative advantages among countries which is at stake here.

One of the most puzzling points, for the economist, however, is the obvious lack of a useful international trade theory, since the classical theory predicting progressive equalization of prices of factors of production (the Heckscher-Ohlin theory) is inadequate and makes unrealistic assumptions and the neo-Marxist theories[9] still lack empirical verification.

In the words of Myrdal:

> (. . .) there will have been salvaged many familiar arguments and theorems now harbored in the broad framework of our general theories, including the theory of international trade, adjusted and fitted into the new structure.

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[7] A. V. Kneese and R. C. d'Arge, op. cit.

[8] Richard A. Falk, "Environmental Pollution as a World Order Problem," in Environmental Policy, Albert A. Utton and Daniel H. Henning, eds., Praeger Publishers, 1973, p. 146.

[9] Arrighi Emmanuel, Unequal Exchange.

> "The changed political situation in the world, the compulsion, implied in this changed political situation, to focus attention on entirely new and very different problems (. . .) are bound to represent the beginning of a revolution also in the social sciences, widening our horizon and radically redirecting our thinking."[10]

The consciousness of the inherent limitations of "spaceship earth" is certainly an excellent illustration of that.

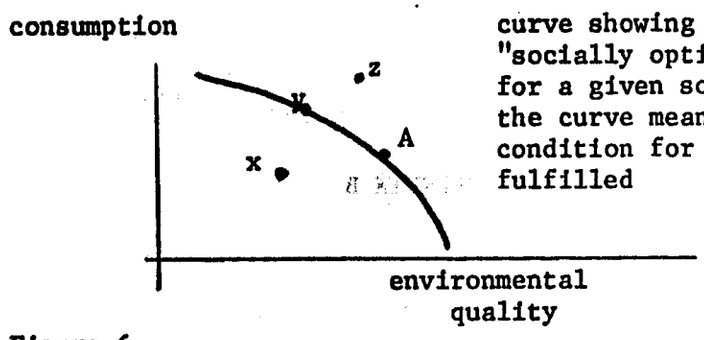
[10] Gunnar Myrdal, Economic Theory and Underdeveloped Regions, Harper Torchbooks, p. 162.

APPENDIX B

On Efficiency in a Multi-objective Planning Context*

As we have tried to make clear in this paper, at any point in time, a choice has to be made by any society between the various components** of the overall social welfare, namely, between consumption goods, environmental quality, social/psychological well-being, and equity. This choice has to be made because resources to satisfy human needs are in short supply.

Let us consider, for example, the two first components:



curve showing the possible "socially optimal pollution point" for a given society--any point on the curve means that the necessary condition for rationality is fulfilled

Figure 6

Owing to the scarcity of resources, we are confronted with the basic problem of efficiency and optimal resource allocation (i. e. best possible).

First, to be efficient, we have to be on the curve (see Figure 6), not in the area inside it. Being on the curve means that the economy is working at full capacity in such a way that the supply of one of the components of social welfare cannot possible be increased without a decrease in the supply of another component. Here, it means that to improve the environment we have to sacrifice a certain amount of consumption and vice-versa. Any point on the curve shows that a necessary condition for rationality is fulfilled. Any point on the curve embodies a different

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* Inspired by "Problems of Environmental Policy in Relation to General Economic Policy," in ECE Symposium on Problems Relating to Environment, United Nations, New York, 1971, pp. 263-269.

** We define these components exactly as in Chapter 3.

choice of the definition of social welfare by this particular society. Let A be this point. Point X is inefficient, point Y is no coherent with the objectives, point Z not feasible. If we take the four objectives, the curve becomes an hyper plan in the four dimensional space, which is a simple extension of the two-dimensional space.

Two different societies will have two different curves, due to differences in geographical, technological, economical differences, and two different optimal points on each of the curves, due to different preferences and definition of social welfare. This shows clearly, too, that two different countries can have very different consumption opportunity costs per unit of environmental quality, i. e. would have to pay very different dollar prices in order to improve by one unit their environmental quality. (This price, or marginal consumption cost of one unit of environmental quality is represented by the negative of the slope at each point of the curve (see Figure 6).

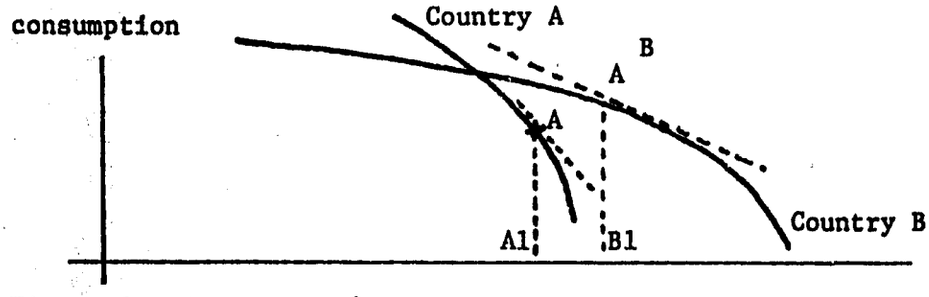

Figure 6: Consumption/enviornmental quality effieiency curves for two countries and their two optimal points of pollution

Note: Even though country B is aiming at a higher environmental quality point than A (because B is on the right side of A). Country B values less environmental quality in relation to consumption than A because the negative of the slope in point B is smaller than in point A. It simply means that in this particular case, technological conditions, socio-economic geographical determinants had more importance than the differences in values regarding the weight to give to the environment.

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THE RELEVANCE OF PLANNING FOR LAND USE AND ENVIRONMENTAL IMPACTS IN INDUSTRIALIZING COUNTRIES

by

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TABLE OF CONTENTS

Page

PART I

I. INDUSTRIALIZATION, POLLUTION AND THE PLANNING DISCIPLINES 1

A. The Land Use Planning Process: An Introduction 2

1. Problem Identification and Analysis: Review of Objectives 3

2. Planning Analysis and Review 3

3. Implementation and Development 4

B. Land Use Planning as Viewed by the Planner 4

C. Land Use Planning as Viewed by the Environmentalist 5

D. Summary: Relevance of L.U.P. and Environmental Planning to Developing Countries . 6

PART II

II. FACTORS GENERALLY GOVERNING PLANT LOCATION AND DEVELOPMENT 8

A. Plant Location Governing Factors 8

1. The Industrial Developer Point of View 8

2. The Urban Center Point of View 11

3. The Urban Region Point of View 12

4. The Environmentalist Point of View . . 12

5. Summary 14

B. Criteria for Industrial Siting 15

1. Statement of Criteria 15

2. The Industrial Developer Point of View 15

3. The Community Point of View 16

4. The Ecological/Environmental Point of View . . . 17

C. The Effects of Environmental Degradation 20

1. Outline of the Major Pollution Vehicles 20

2. Air Pollution Effects 21

3. Water Pollution Effects 22

4. Solid Waste Pollution Effects 23

5. Noise Pollution Effects 25

6. Heat Pollution Effects 27

7. Visual Pollution Effects 29

PART III

BENEFITS FOR THE FUTURE 31

BIBLIOGRAPHY 32

PART I

INDUSTRIALIZATION, POLLUTION, AND THE PLANNING DISCIPLINES

Introduction

At a time when the world community is developing on all fronts at breakneck speed, the peoples of that community are being made more and more aware of the fact that they are truly members of a "global village"; that they are, in fact, part of a closed ecosystem; and that they do, in fact, affect that system with each intrusion upon it. It should be very clear that the impacts of human development on the ecosystem are directly related to advancement of the developing technologies. In this point lies the fundamental question we are facing today. As the leaders of the world communities make technological advances in industrial methods, the less advanced countries profit to the extent that with methodological refinement, their processes are passed on to the world community at large.

With the development of this "global village", due mainly to increased communication linkages and information handling, a new phenomenon has presented itself which must be taken into account. This is the irreparable damage being done by man to his irreplaceable environment. When the world is viewed as a closed system, our formerly "free" natural resources of air, water, and land must take on immense value as

irreplaceable and finite elements. To misuse them or to use them carelessly invokes irreversible damage to the entire ecosystem affecting not only the immediate environment but also the world environment; not only the local populations but also the world populations. The effects which can more easily be seen and appreciated at the local level can have, nevertheless, far-reaching consequences to the world as a whole. It is within the scope of this paper to discuss the effects of this problem of industrial pollution primarily at the local scale. In particular, this problem will be investigated with regard to roles played by the land use planning and environmental processes as they apply to the impact of industrialization. It will be assumed that, given industrialization, there are unavoidable consequences of environmental pollution which result. These consequences have not only immediate health and safety impact and danger on the local environmental context, but also on the world at large. These health and safety impacts can be appreciably reduced by effective land use and environmental planning policies and controls.

A. The Land Use Planning Process: An Introduction.

The Land Use Planning Process can be generally viewed as a three-part process broken down as follows: Problem Identification and Analysis and Review of Objectives; Planning Analysis and Review; Implementation and Development.

A-1 Problem Identification and Analysis; Review of Objectives

Problem Identification and Analysis consists, very simply, of defining existing problem contexts and inventorying the state of the physical community at that point in time. It is on the basis of this inventory that one sets goals (after having defined needs of the people), develops objectives reduced from the goals, and operationalizes these objectives in terms of some evaluation criteria and planning principles and standards. During the phase of defining the planning context all physical data necessary is massed using the "tooling up" techniques of the profession. Minimum requirements here are: population, existing and projected; employment, existing and projected; energy needs; varied and renewal land inventory; stock of dwelling units; summary of substandard dwelling units. In light of this data and an overview of the definition of the problem a review of objectives is held either with or without local level citizen imput. Citizen imput is much preferred here.

A-2 Planning Analysis and Review

Planning analysis based on the data at hand is carried out by an indepth projection of actual physical needs, balanced with actual holding capacities of the environment, balanced with the socio-economic criteria describing the market forces of these variables. Given variations in these factors (either real or anticipated) a set of alternative plans is developed, tied together and substantiated by policy guides and action instruments as proposals of alternative courses of action. Based on internal feasible criteria or external

input the plans are adopted or rejected

A-3 Implementation and Development

If adopted, action decision implementation steps are taken based on the proposal action instruments and codes are prepared and developed to see the plan into actual physical development. This, of course, takes place after extension policy and action instrument review and approval. Once implementation is under way new inputs from the physical world are monitored and the whole process changes or recycles as the context changes due to these imposed changes on it.

B. Land Use as Viewed by the Planner

It is an undeniable goal of the land use planning profession to guide development in such a way as to make optimum use of the context (the land and environment) and not to destroy it by overusing or misusing. Immediately this goal is operative at two distinct levels of development: the regional and the urban local level. At the regional level of land use planning activity, one generally accepts the viewpoint that land use is resource oriented. That is, that land use management is conservation and/or custodially oriented. The objectives are regional or national management of normally limited natural resources, typically land, water, air, mineral wealth, forests, etc.; conservation and use for the present and future. The local viewpoint is at times conflicting with the regional since the emphasis here is development oriented and therefore physically land use oriented. Major factors involved are land exchange, economic development in the form of industrialization and land degradation from pollution caused by these uses.

It is at this local scale that problems of environmental pollution become critical at the same time they become treatable--at the source of the pollution.

C. Land Use Planning as Viewed by the Environmentalist

These considerations suggest the fact that land use planning can be viewed from two different perspectives. The above detailed point of view is that of the land use planner himself who sees his goals as generally market oriented in which land is a commodity to be allocated to the general public through the market mechanism. From his point of view environmental objectives appear as constraints which have to be considered in achieving the general land use goals. The second point of view is that of the environmentalist. His objectives are to preserve the important natural features of the environment, provide for diversity in use of the environment without degradation thereof, and to enhance natural renewable resource quality to the greatest extent possible by recycling maximization of nonrenewable resources. It should be obvious that the environmentalist is also very much concerned with the question of the role of economics in the planning process. In fact, it is the environmentalist who, through his concern for the natural processes, acts as a watchdog for mankind to prevent the misuse and consequent deterioration of depletable natural resources to provide for their continued and economically efficient use; and who can call attention to spin-off effects of industrial development which often cause excessive and unplanned costs to the developer and society. From this point of view, the land use planning process becomes a means of

implementing and achieving environmental objectives and goals. That is, land use control decisions and regulations can be the means by which environmental objectives are realized.

D. Summary

Relevance of L.U.P. and Environmental Planning to Developing Countries

In summary then, we are dealing here with two levels of planning, the regional and local; and two viewpoints of planning, that of the environmentalist and that of the land use planner. As was alluded to above, man as the social animal functions in a context of processes of development (environmental) which is economic and political. A second functional context, the ecological context, however, is evolutionary. This has important ramifications for industrialization, and development in general, because the resources required by man originate in the ecological context and most always return to it--usually in the form of wastes. Obviously, since land is the medium which will retain these wastes, usually transferred from fluid media, the capacity of the environment to assimilate the wastes is determined by topographic, and geophysical characteristics. This assimilative capacity should be one of the key criteria for industrial siting, a point to be developed more fully below. Land use planning methodologies seek to balance the human sector factors of development and the ecological sector factors by guiding development into regions of high assimilative areas. It follows that planning should provide a generally good climate for development, in that it directs and guides to the extent possible the type and spatial location of development, as well as identifies

the best lands for industrial location based on the regional or local level objectives. The inventorying and analysis of this information in itself provides the community (local or national) with an invaluable base of information on which to build and expand in an orderly more systematic way.

PART II

FACTORS GENERALLY GOVERNING PLANT LOCATION AND DEVELOPMENT

With the foregoing general overview of planning from the land use and environmental perspectives, the specific factors generally governing industrial plant location and development will be outlined in the following pages. These factors will be discussed in terms of criteria for siting and resultant environmental impacts. In order to have a complete understanding of the meaning of these factors, four perspectives on these problems will be presented. These are the viewpoints of the industrial developer, the urban center, the region (or nation) and the environmentalist.

A. Plant Location Governing Factors

A-1. The Industrial Developer Point of View

In looking for an industrial plant location the developer is directed almost entirely by the economic efficiency objective. Whether it is a multinational corporation doing an international development project or a local manufacturer establishing a new production center, his primary motive is profit, and the site he chooses will reflect this attitude. With this in mind, there are fourteen generally accepted basic location factors which will guide the developer in making a site decision. These factors, in no special order, are:

1. The location of production materials
2. Labor
3. Sites (availability choices)
4. Fuel sources
5. Transportation net

6. Distribution facilities
7. The Market
8. Availability of water
9. Availability of power
10. Availability of housing, communities
11. Prestige of location and services
12. Favorable climate
13. Laws and regulatory agencies
14. Tax structures

One can be certain that the developer will consider a balance of all these factors in some form of cost/benefit analysis to determine the best possible location to maximize his land cost benefits. A brief analysis of the factors treated as a series of questions follows:

1. Location of production materials--what materials necessary for use are to be found in the areas under question? In what balance? In what quality? And how easily accessible?
2. Labor--what is the quality of labor in the area under question? What is the quantity of the labor force: The character of the labor force? The seasonal changes of the force?
3. Sites--how much land is available? What are the topographic and soil characteristics? What support facilities are and will be available? What does the land cost? What is the availability and general state of available structures?

4 Fuel sources- what are the existing dependable (over long range planning spaces) and cost accepable fuels available in the area?

5. Transportation net- what facilities and services are available? How do they compare in rate and time/distance terms with other industrial areas?

6. Distribution facilities - what agencies and support services are available?

7. Market - what is the market quality and service area under consideration?

8. Availability of water - what is the additional industrial carrying capacity of the existing water supply? What is the cost and quality of water?

9. Availability of power - what kind of power, furnished by whom, is available? Is the power source dependable over a long term planning period? What does it cost?

10. Availability of housing and amenities - what are the existing available facilities and service amenities and are those facilities adequate?

11. Prestige of location - does the location offer opportunity for self-advertisement and/or otherwise lend status to the region?

12. Climate - what are the area climatic characteristics? What, if any, effect do they have on production?

13. Laws and regulatory structures - what are the significant restrictions concerning industrial development and its impact on the area?

14. Tax structures - to what degree is the tax structure favorable to industry?

A-2. The Urban Center Point of View

The point of view of the urban center changes the character and relevance of the above mentioned factors considerably, depending upon the planning goals and objectives to which it holds. It is here that a multiple objective function of planning comes into play and a real balance of amenities is sought. In the extreme, but in a growing number of situations, particularly in the highly industrialized areas of the world, industrialization has become a phenomenon which is not always sought after regardless of the potential economic gain to the area. In these instances, costs of industrial pollution, congestion, and urban sprawl (to mention a few considerations) to the society are judged too great a cost to pay for the normal benefits of industrialization. Obviously, some of the factors drop out of consideration in this situation and are simply absorbed as existing givens in the society situation.

By and large. the phenomenon which takes place is that essentially the same questions are asked but the objective is different as alluded to above. The urban center policy for development is directed toward balancing objectives of economic efficiency, health and welfare, environmental considerations, etc., for the broad population. Although all of the factors are present to be analyzed from this point of view, trade-offs among them are much more prevalent. The questions are not directed toward the support of development per se, but

are directed toward the social, political and economic welfare of the community as a whole. For example, a community might choose to develop an industrial park outside the center at additional cost rather than disrupt residences and urban traffic and living patterns within the existing structure.

A-3. The Urban Region Point of View

Consideration of the urban region as a whole can be viewed in a similar manner. Again the objective function of planning is a multiple objective function which addresses the question of land resource allocation to achieve general social, political,and environmental goals for the general welfare. One of the problems which can arise here is that one part of the region may contain a vastly different urban center resource base. This imbalance requires that equity distribution within the entire region become a major focus of planning. An example would be the situation where industry is located not in a high resource area of a region but in a high labor source area which is depressed and to which a transportation net is built to accommodate the imput of resource. In this case,the transporation net and the industry will stimulate growth and build up the income base of the two areas.

A-4 The Environmentalist Point of View

A fourth viewpoint to be considered is that of the environmentalist. This is a rather unique position from which to view development planning because the goals seem on the surface to be in opposition to those of the aforementioned actors. This poses no problem, however, since they actually

seek to maximize (in a multiple objective way) benefits for the general welfare. The environmentalist does not discourage industrialization and/or development per se but only to the extent that the effects of development do not misuse or damage the world's irreplaceable resources including air water, minimal reserves, etc. Technology, at the same time that it has advanced development, has advanced techniques for monitoring the polluting wastes resulting therefrom, and has developed maximum resource use techniques in recycling procedures. Even with these developments, however, industry continues to have detrimental impacts on the environment which are of major concern to the health and safety of the world at large--the addition of pollutant gases to the air, the heating of waters used for cooling purposes, the lowering of water tables and drying up of water sources are but a few examples. In actions such as these, man wantonly destroys the ecosystem over time because the environment cannot assimilate the wastes dumped into it. This is the major constraint on his development activities. It is the environmentalist's viewpoint that as man demands of his environment to produce greater energy and materials, he automatically increases the costs of any effort to stabilize the ecosystem and to predict its reaction to new impacts. His concern, then, is with the capacities of the environment to absorb and assimilate the resulting impacts of his development. In a particular case, the developer's questions become: Can the environment support the industry? Is there enough water? Is the soil sufficiently stable? Can the atmosphere assimilate additional waste gases? The locational factors for industry

that are important to the environmentalist, and to the developer himself, are derived from these issues. However, the questions are posed in a different manner. The environmentalist would not only ask if there was sufficient water for the industry but would also investigate the effects of the industry on using the water. He would want to know if the environmental carrying capacity of the available water was such that it could assimilate the industrial demands on the hydrologic system completely or at least without harmful effects to the environment. The same analysis would carry through to all environmental features imposed on by the industry.

A-5. Summary

One finds, then, that there are four points of view from which one can view the industrial location problem. These are: the industrial developer point of view; the urban center view; the regional (or national) view; and the environmentalist view. The developer is generally and very simply profit motivated, the urban center is motivated by a development potential balanced by public welfare objectives, depending on its state of affluence; the urban region (or national region) is largely development encouraging with some welfare objective structure,depending on the state of development of the region; and the environmentalist is conservation-protection oriented with his objective function placing great demands on balanced resource use and maximum use of resource potentials through recycling processes. With these thoughts in mind, it is now necessary to address the question of criteria for industrial siting.

B. Criteria for Industrial Siting

B-1. Statement of Criteria

As in the previous discussion on factors of siting, it is useful to review the criteria for industry, from three viewpoints. These are: the industrial developer view; the community viewpoint (the persons directed affected); and the ecological viewpoint. There are five generally accepted criteria under consideration in the choosing of an industrial location. These are: health and safety criteria; economic criteria; aesthetic criteria; environmental quality criteria; and equity in the distribution of general benefits. The following is an outline of these five criteria for siting as they apply to the three points of view under consideration.

B-2 The Industrial Developer Point of View

The industrial developer is primarily investment oriented. He is interested in maximizing his profits and will always set as his objective that of economic efficiency of construction and operation. His criteria for plant location will seek to minimize locational costs. Environmental criteria dictate that he seek to minimize damage from the natural phenomena such as floods. He will invest in soil analyis to determine the danger of weak foundation support and he will generally seek a site that will pose few construction problems (i.e., topographic changes, earth moving, etc.). In these cases where there is large dependence on raw materials, economic efficiency criteria will hinge on questions concerning proximity to natural resources as opposed to shipping costs.

The industrial developer is concerned with the additional criteria largely as they relate to efficiency of operation and not necessarily to site location. These criteria enter more importantly in the actual plant design once the site is chosen or are imposed on the developer in his site choice by the community. One might be led to view the criteria other than economic efficiency as subsets of those which are actually constraints on the developer-industrialists imposed from the outside.

B-3. The Community Point of View

The community view of industrial location criteria is much more complex. At some point all of the criteria outlined above come into play because the community represents a wider range of interests with many objectives for development. It is helpful to look at the question as an effort to balance the socio-political forces of society against the economic force in terms of net gross for the general public welfare. For example, the location of industry in a community will provide jobs for the residents and increased economic surplus for the area (in the first development cycle). Depending on the industry, this may cost the community in terms of increased vehicular circulation and congestion; crowding due to influx of new employees; less clean air due to industrial pollution problems; a less pleasing visual environment in the site area due to industrial architecture; and also, depending on the industry, an unequal distribution of employment opportunity, misuses, and other related factors. Health and safety factors alone play a critical role in site selection choice from the point

of view when one considers the high risk danger industries such as biochemical and nuclear related development projects or the noise intensive developments such as airports and highways. The point is that one cannot simply justify the location of new industry in a community in terms of economic efficiency criteria. The real costs to the community may come from factors other than those which will not be felt until long after the initial investment is made, but which will have greater and longer lasting effects on the general welfare than could ever be justified for simple economic gain in the short run. When one considers that with each new industrial development project secondary and tertiary cycles of development follow, this problem takes on an even greater significance.

In the case of a primary extraction industry, for example, secondary supply industries will follow it into an area as well as user industries. These will again raise employment, but will cause a new influx of people into the area, cause more congestion, more pollution, more visual degradation and so on. If the development is desirable (which in most cases it is), it then becomes the mandate of the community to minimize these costs by planning in advance how the development will take place and what trade-offs are necessary to make that growth efficient and least costly for the general welfare in the short and long term.

B-4. <u>The Ecological/Environmental Point of View</u>

Ecological consideration of industrial location criteria provide the third viewpoint from which to view site choice. There are essentially two points to this view.

The first concerns the environmental impact of the initial construction phase; and the second concerns the environmental impacts due to continued operation of the industry. The primary concerns here are the maintenance of environment and the reduction of all degradation of the environment to the extent that it is technologically feasible. The criteria for site choice are essentially environmental quality, health and safety, and aesthetic criteria with trade-offs often taking place involving economic efficiency and equity. This does not mean, however, that the economic efficiency for siting is any less important. Because to be most effective in chossing a site for industry, these other factors are best expressed in terms of economic efficiency in order to compare the advantages and disadvantages of site choice in terms of a concrete monetary unit. The short run effects due to the construction phase of industry include such impacts as noise, silting of drainage channels, destruction of vegetation and displacement of animal (and human)habitats within the specific site area. These impacts are generally confined and normally restricted to the period of construction with environmental restabilization taking place once the construction period is over. The displacement of human habitat and current use of the land can have significant effects here in economic efficiency terms if the displaced populations are large or if the current land use is economically intensive as in prime agricultural areas.

It is in the second area of concern that ecological consideration is of major importance and environmental quality

quality controls become critical to plant siting. It is here that one must account for long term degradation of the environment through the industrial discharge from manufacturing processes, waste disposal, heat generation, and gaseous and particulate emissions, to mention only a few. As noted earlier, there is also the latent danger of total environmental destruction in some of the more high risk industries (biochemical and nuclear). Even though this danger may be exceedingly small, statistically the psychological, social, political, and real impacts of the siting of such industries is of paramount importance and must be carefully considered. This becomes a criteria of relative importance in remote, unique and scenic areas where failure of industrial controls could render the adjacent areas unfit for further human use. The case alluded to previously in discerning the community biases for industrial siting criteria is the more obvious case in point here. The high risk industries are, in most cases, forced to seek sites in remote desolate areas where the risk to human life is completely minimized or restricted to the "operational accident" type of risk.

Luna B. Leopold, with the aid of others, has developed a very convenient environmental impact evaluation matrix[1] which can provide the developer with an impact evaluation guide when making a site selection choice. The guide, which is to a large extent subjective in its categorization of causes and effects,

[1]Leopold, et al., A Procedure for Evaulating Environmental Impacts, Washington: U.S.G.S., Circ. 645,1971.

crossranks "Proposed Actions Which May Cause Environmental Impacts" with "Existing Characteristics and Conditions of the Environment". These major categories are then subdivided into two progresively smaller divisions in an attempt to list all possible major impact areas and to define points where conflict may occur between various elements. Areas of conflict are noted on the matrix and the conflict is then subjectively ranked from 1 to 10 in terms of the Magnitude and Importance of the particular effect in question.

Due to the subjectivity factor in the model and the fact that project variation can be very great, the model cannot possibly be universally applicable. The point is, however, that it does provide a very simple method for defining the relatively greatest environmental impacts as viewed by those who are assessing a given project. The advantage of using such a matrix form lies in the fact that it provides a ready checklist of the range of actions proposed and their respective impacts. Once the impact range is established this information can be used as input into a cost/benefit type of analysis to further aid in the development of siting choices.

C. The Effects of Environmental Degradation

C-1. Introduction

In the foregoing discussion of siting factors and criteria for site choice, the problems of pollution have been alluded to and in some cases developed in some detail. It is important at this point to outline the major pollution vehicles under consideration and analyze briefly their effects on human life. For this purpose the following six pollution subjects will be discussed:

1. air
2. water
3. solid wastes
4. noise
5. heat
6. vision

Although it is recognized that some of these can be treated together under the general goal umbrella of environmental quality criteria, it seems more comprehensible here to discuss these issues separately for reasons of simplicity.

C-2 Air Pollution Effects

The envelope of air which surrounds the world was thought until recently to be unaffected by the products of industry or the artificial environment which man was creating for himself. With the development of concentrated industry, however, man suddenly found that he was dumping gaseous and particulate wastes into the air in enormous quantities which was having a detrimental effect on his health and life style. The oxides of sulfur, nitrogen and other chemicals escaping into the air as plant waste products were found to be killing vegetation in their path. Particulate matter concentration in urban areas was linked to emphysema and cancer as causitive elements, and radioactive particles escaping from nuclear facilities found their way into milk supplies and eventually human consumption resulting in sickness and in unique instances of death. In recent months research has uncovered a potentially pollutant in the gaseous propellant used in aerosol sprays.

Studies indicate that this gas attacks the vital ozone layer of our atmosphere and in so doing, has the potential of completely destroying the earth's primary protection against solar radiation. The list of examples of air pollution sources and effects is long and growing. The point to be made here is that where any industrial development takes place air pollution is present and should be planned for at the micro and the macro scale. The effects can be felt at the local level in terms of such phenomena as smog, but the final effects will be at the macro scale in a general degradation of the world's total air supply.

C-3. Water Pollution Effects

The effects of localized development on water resources is much more localized. Pollution of water can take place in generally two ways: the dumping of liquid or solid wastes into the hydrologic system; or by the addition of heat to the system. In the former case, the wastes can directly kill the life in the water supply by poisoning it or it can overload the biological oxygen demand of the stream,effectively eliminating the natural characteristics of the water system to assimilate organic waste matter by natural biological processes. Probably the prime concern in the question of water pollution is the effect it will have on the water sources for personal consumption. Obviously, if pollution were to be allowed to go totally unchecked, the changes to human life through poisoning would be immeasurable. The addition of heat to a water source comes primarily from the use of water as a coolant in

in manufacturing processes. Up to a point, heat can stimulate biologic growth in a water supply which will cause an overburden on the assimilative capacities of the supply. The addition of too much heat to such a supply will kill the organic life in it, destroying the whole water ecology. This problem of heat dissipation through a natural water system has produced some interesting environmental assimilation experiments, however. The heated water is used to stimulate growth of certain types of fish and other aquatic life which would normally life in warm climates, thus providing possible new food sources.

C-4. Solid Waste Pollution Effects

The largest sources of solid waste problems are mining, mineral processing, agriculture and animal raising.[2] However, industrialization and urban development in general produce substantial input to the total waste management problem. This problem is, and has been since time began, a problem of collection and disposal of waste. The normal attitude toward the subject has been one of laissez-faire which has added to the problem. It has always been a labor intensive operation and directed by an "out-of-sight-out-of-mind" general public attitude, two factors which are at the base of the dificulties now facing society.

The specific effects of these problems on the population are several and may be thought of as follows: land

[2] "What's Ahead in Solid Waste Management", Battelle Research Outlook, Vol. 3, No. 3 (1971).

use effects due to incineration and organic decay; water pollution from leaching processes in which ground water sources are polluted, and visual pollution due to dump sites, to name only a few. It should be obvious that in practically all of these sources of pollution, the general health and welfare of the adjacent populations is affected. The concentration of wastes in one area such as described here, for what ever reason instantly lends itself to the propogation of disease and health contamination effects detrimental to society. In a world society which is fast developing attitudes of general wasteful consumption in the sense of a use-once-and-discard philosophy, one loses sight of these effects. The groundwork and, in fact, some of the most advanced thinking concerning waste management approaches have been done by Resources for the Future, Inc.[3,4,5,6] The basic idea of management developed is to expand the context of the problem to include the entire product generation cycle from raw material extraction to product disposal. It is for this reason that the World Bank in its environmental impact guidelines concerning waste management suggests that emphasis be placed on materials and their assimilative capacities back into the environment as a last resort. Treatment (collection and disposal) should not

[3]Knare, Ayres and D'Ange, Economics and the Environment: A Materials Balance Approach, Resources for the Future, Inc. (Baltimore:Johns Hopkins Press, 1970).

[4]Bower, et al., Waste Management: Generation and Disposal of Solid, Liquid, and Gaseous Wastes in New York Region, New York: Regional Planning Association, 1968.

[5]Walter Spofford, "Solid Residuals Management", National Resources Journal, Resources for the Future, Inc., Vol. II (1971)

[6]Blair Bower, "Integrated Residuals Management", Resources for the Future, Inc., mimeo, February, 1972.

be thought of as a final solution, but as a part of the solution in making materials reusable or more easily assimilated by the environment. The result will be a great reduction in solid waste materials and a correspondingly great reduction of the entire problem.

G-5. Noise Pollution Effects

The problems dealing with noise pollution have only recently come to the forefront of environmental quality analysis even though the problem has long existed on the industrial frontier. Here it has been generally recognized as an annoyance and actual health problem since the industrial movement got under full swing. As outlined in the Environmental Protection Agency, Report to the President and Congress on Noise, (Washington: U.S. Government Printing Office, 1972), the effects of noise overload on the general health are as follows:

1. Minor to permanent damage to the inner ear resulting in malfunction or total deafness.
2. Intermittent hearing loss to permanent chronic damage to hearing with repeated exposure to noise overload.
3. Disruption of speech communication and the perception of auditory signals.
4. Sleep disruption.
5. Interference with the ability to perform complex tasks, particularly when dealing with speech and auditory reception.
6. Annoyance and disruption of thought processes.

7. Source of mood disruption and general disturbance of relaxation.

The most prevalent source of noise pollution is ground transportation while the most intensive is that caused by aircraft.[7] The major remaining sources are construction, industry and finally, residences. Unfortunately, the development trends of society favor the growth of the first two groups--largely for cost-efficient reasons. Air and ground transport are growing larger due to the obvious economics of scale involved, and with them the increased pollution problems. With the definition of these problems, one is faced with the tasks of finding appropriate solutions and some means of implementing them. Probably the greatest stumbling block in this process is that the solution must be primarily cost efficient and at the same time account for the other inherent pollution abatement criteria, particularly the health and welfare functions. In terms of land use planning this suggests a very small and difficult solution field to obtain since transportation arteries, industrial complexes, and construction in general are developmental areas which must traverse the quieter environments. In other words, they are self-concentrating to a great extent. Even air transport facilities, although generally located outside urban areas, are growth generating and soon find themselves intensifying noise pollution through second generation growth

[7] Committee on Environmental Quality, Noise-Sound without Value (Washington: U.S. Government Printing Office, 1968), p. 16.

adjacent to the facility site. In a situation such as this, one is confronted with the unfortunate realization that those ramifications and general consequences of noise pollution are not understood by the public at large who will choose to "suffer with noise" in order to maximize some other function such as short home to work travel time--an excellent example of the way in which education and planning should go hand in hand to increase the general welfare function through increased general knowledge.

C-6. Heat Pollution Effects

The effects of heat on the world ecological system are becoming more and more a source of concern for the population. Essentially all industrical processes pollute the environment with some residual quantity of heat ranging from practically none to a residual heat production in nuclear power stations of two parts heat produced for every one part electricity.

The heat, no matter how generated or processed, eventually ends up in the atmosphere from radiation as an air pollutant. In this capacity the heat damage can manifest itself in changes of the micro and macro climates which can have major detrimental effects on crop production cycles, for example. Since electric power generation accounts for more than 80 percent of the cooling water use in the U.S., one can immediately see that it is in the heating of water systems that the more significant effects can occur. Here the primary detrimental effects are twofold: 1) the increased temperatures can simply kill aquatic life processes, such as growth and

reproductive patterns. In addition to the outright "physiological effects of heat on aquatic life in (1) above; the myriad ramifications of (2), which are difficult to analyze and practically impossible to predict, are probably the most critical. This is because minor changes in one food chain, for example, can result in destruction of highly complex ecological balances of far greater consequence to other species in the environment. The overall picture is, however, not beyond the range of remedy, especially in the heat intensive industries, where economies of scale can be realized. Proposals have been made, for example, using the heated water in intensive "Industrial Agriculture" techniques which use water for cooling, to use the heated water to stimulate crop growth which furnishes raw materials input for food processing and/or animal production, which, in turn, furnishes a nutrition base for the production of organisms (like protein-rich algae), using waste as a substrate.[9] Concerning land planning activities, the major effects of heat pollution result from those industries using water as a cooling agent--primarily the electric power industries Here is the simple planning concern for space. On the nuclear power site, the space is needed for large cooling ponds, and for reasons of health and safety, to assure great distances from urban populations; coal intensive utilities need

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[8] J. B. Hobby and B. J. Copeland. "Biological Effects of Heat Added to Natural Waters," N. C. Nuclear Environmental Workshop. Pinehurst, North Carolina (October, 1970).

[9] L. Boersma. "Warm Water Utilization". Presented before the Conference on Beneficial Uses of Thermal Discharges sponsored by the New York State Department of Environmental Conservation, Albany, New York (September, 1970).

enormous space for cooling ponds, as well as for the storage of coal and for the elimination of waste ash. Even when cooling towers are used, which seems to be the trend depending on the plant size and tower efficiency, the enormous heat outputs largely determine location due to the need for placement near water resources.

C-7. Visual Pollution Effects

Visual degradation of the environment is, and has always been, difficult to assess and until recently has been accepted as one of the costs of industrial development. In essence, the visual impacts of development can be grouped into two types: those due to construction and the general visual disruption of the existing site state by it; and the visual impact of the development after it is in operation, the continuous visual pollution. The former type is relatively short-lived, depending on the scale of the development project, and consists generally of degradation of the site ecology by disruption of animal habitats; the destruction of flora and fauna; air pollution in the form of dust, smoke and noise due to site clearing, earth moving, and construction of temporary or permanent access roads; water pollution in the form of clouding and solid waste addition due to silting and disruption of the natural hydrologic system in the area, especially where water is an important raw material); and visual pollution through these combined processes which destroy the ordered natural environment or contrast with the urban environment whether it be ordered or not. Visual degradation of the more permanent form is a more complex problem

with which to cope since its roots are found in a definition of what is aesthetically beautiful or, at least, unobjectionable to the human eye in terms of amenity. It would seem that three philosophies are at work here. The one is to develop with no regard to either the surroundings or the form of the industry so long as it is economically efficient. The second and third are variations of the idea to minimize visual impact by 1) making the development to look physically like its surroundings or at least not intrude upon them by gross and exaggerated differences in form, color, etc. or 2) hiding the structure far from the population or within a confining enclosure. Obviously, the third alternative has important land use ramifications since it implies isolation in the landscape--a situation relatively difficult to find and normally expensive to support.

PART III

BENEFITS FOR THE FUTURE

In the foregoing discussion the purpose has been to describe the land use and environmental planning processes and to indicate some of the advantages of following their respective methodologies in the siting of industrial facilities. These advantages have been pointed out by illustrating both the types of harmful industrial pollution effects which can be avoided as well as some of the multipurpose benefits which can be gained by careful planning consideration.

It should be clear at this point that as our world society becomes more and more complex, the land use and environmental determinations of one locality, region, or nation can often have profound consequences for the citizens of other areas, as well as those immediately affected. However, through a proper balancing and planning for these determinations much of the future resource waste and lost effort in development should be avoided.

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THE ECONOMIC IMPACT OF ENVIRONMENTAL PROGRAMS

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CONTENTS

1974 Abatement Cost Estimates

Distribution of Costs by Sector

Distribution over Time

Distribution between Investment and O&M Costs

Macroeconomic Impacts

Impact on Inflation

Impact on Investment, Productivity, and Economic Growth

Impact on Employment

Impact on Government Finances

Impact on Foreign Trade

Impact on the Distribution of Income

Impact on Specific Industries

References

Notes on Methodology

Other Analyses on Economic Impacts Released by CEQ

Tables

I. Estimated Incremental Pollution Control Expenditures
II. Investment for Air and Water Pollution Abatement by Industries, 1973
III. Investment for Air and Water Pollution Abatement by Industries, 1974
IV. Percentage Contribution to Price Indices with Pollution Control Expenditures
V. Plant Closings Where Pollution Control Costs Were Alleged to be Factor, January 1971-June 1974
VI. U.S. Budget Outlays by Function, 1973 Actual and 1974-76 Estimated
VII. Manufacturing Energy Consumption, Selected Industries, 1967
VIII. Pollution Control Expenditures as a Percentage of Value of Shipments, Selected Industries, 1973 and 1980

Figures

I. Percent Contribution to Change in Wholesale Price Index, April 1973-April 1974 (by Major Commodity Groupings)
II. Projected Economic Growth, 1974-1982
III. Projected Unemployment Rates, 1974-1982
IV. Pollution Abatement Expenditures for New Plant and Equipment by Selected Industries, 1973
V. Pollution Abatement Expenditures for New Plant and Equipment by Selected Industries, 1974

THE ECONOMIC IMPACT OF ENVIRONMENTAL PROGRAMS

The Council on Environmental Quality (CEQ) has, since its inception, taken a major responsibility for assessing the economic abatement costs the Nation can expect to face as a result of current Federal environmental legislation.[1] The Council carries out other in-house analyses or contracts for studies concerning the economic impact of these programs. This memorandum summarizes CEQ's 1974 estimates and analyses. Additional supporting papers are available upon request. (See page 24.)

1974 Abatement Cost Estimates

The CEQ's estimate of abatement costs for the ten-year period 1973 through 1982 are given in Table I. These "incremental" abatement costs are those abatement costs projected to meet the requirements of Federal environmental legislation enacted since the mid-sixties, beyond what the Nation would have spent for the same purposes in the absence of this legislation. Four types of costs are shown:

- "Investment costs" (for the period 1973-1982) which are the estimated expenditures which will be made on capital equipment for pollution abatement by both public and private sectors.

- "Capital costs" which include interest charges on pollution control investments and the depreciation of the capital equipment.

- "O&M costs" which are the costs of operating and maintaining the pollution abatement processes.

- "Annual costs" which are the sum of the capital costs and the O&M costs. The last column in Table I shows the sum of annual costs projected for each of the ten years 1973, 1974,...1982.

These abatement costs are estimated primarily from data provided by the Environmental Protection Agency (EPA) and other Federal agencies. The air pollution abatement costs are based primarily

on the 1974 edition of The Cost of Clean Air,[2] and the private water pollution abatement costs are based primarily upon the 1973 edition of The Economics of Clean Water.[3] The cost estimates predominantly assume the installation of "end-of-the-pipe" treatment for air and water pollution abatement, and thus understate potential for less costly production process modifications which also satisfy legislated abatement requirements. For this reason, and because CEQ's unit cost assumptions are generally high, the cost estimates are considered to define, on the basis of current knowledge, the maximum likely costs the Nation will experience. However, not all of the costs associated with meeting the 1983 goals of "best available technology" are included because of uncertainty about the degree of abatement that will be required for many industries.[4]

Cumulative abatement costs (in constant 1973 dollars) over the 1973-82 period are estimated to be $194.8 billion. This estimate is approximately $42.1 billion (28 percent) higher than last year's estimate. However, only $10.1 billion of this increase represents a net increase in real cost estimates (primarily stationary air pollution control). The remainder of the increase resulted from:

Changing the estimating period from 1972-81 to 1973-82 (in essence, dropping 1972, a relatively low cost year, and adding 1983, a higher cost year).	$20.5 billion
Inflation (changing from 1972 dollars to 1973 dollars).	$11.5 billion

Distribution of Costs by Sector: Approximately $77 billion of the cumulative costs (mobile sources and solid waste collection costs) is paid for directly by the consumer. Another $32 billion is initially paid by government and passed through to taxpayers. Of the remainder, $32 billion will be paid by electrical utilities and the rest by other industries. These costs will be predominantly passed on to the consumer in the form of higher electricity and product prices.

TABLE I

ESTIMATED INCREMENTAL POLLUTION CONTROL EXPENDITURES[1]

[In billions of 1973 dollars]

Pollutant/medium	1973			1982			Cumulative - 1973-82		
	O&M[2]	Capital costs[3]	Total annual costs	O&M[2]	Capital costs[3]	Total annual costs[4]	Capital invest-ment	O&M[2]	Total[4] annual costs
Air pollution									
Public	.1	.1	.2	.5	.2	.7	1.7	3.8	5.4
Private									
Mobile	1.2	.2	1.4	8.4	4.9	13.3	31.3	49.9	74.4
Industrial	.5	.7	1.2	1.3	1.1	2.4	8.4	11.6	24.5
Utilities	.5	.3	.8	2.7	1.2	4.0	7.9	19.6	29.0
Total	2.3	1.3	3.6	12.9	7.4	20.4	49.3	84.9	133.3
Water pollution									
Public									
Federal	.2	NA	NA	.2	NA	NA	1.8	NA	NA
State and local	1.1	.1	1.1	1.4	1.3	2.7	14.8	12.8	24.4
Private									
Industrial	.5	.5	1.0	1.5	1.2	2.6	9.8	12.3	23.1
Utilities	0	0	.01	.4	.3	.7	4.4	2.2	3.5
Total	1.8	.6	2.1	3.5	2.8	6.0	30.8	27.3	51.0
Radiation									
Nuclear powerplants	NA	NA	NA	.05	.05	.07	.3	.08	.3
Solid waste									
Public	.1	.1	.2	.3	.1	.4	1.0	2.2	2.9
Private	.1	<.05	.1	.5	<.05	.5	< .05	2.3	2.3
Total	.2	.1	.3	.8	.1	.9	1.0	4.5	5.2
Land reclamation[5]									
Surface mining	.3	0	.3	1.6	0	.6	0	5.0	5.0
Noise[6]	NA	.1	NA	NA	1.0-1.4	NA	6.0-8.7	NA	NA
Grand total[6]	4.6	2.0	6.3	18.8	10.4	28.0	81.4	121.8	194.8

1/ Incremental costs are expenditures made pursuant to Federal environmental legislation, beyond those that would have been made in the absence of this legislation.

2/ Operating and maintenance costs.

3/ Interest and depreciation.

4/ O&M plus capital costs.

5/ Includes coal mining only.

6/ Not included in grand total.

TABLE II
INVESTMENT FOR AIR AND WATER
POLLUTION ABATEMENT BY INDUSTRIES, 1973

	Total plant & expenditures	Pollution abatement investment: End-of-the-pipe & process change			Pollution abatement investment: Process change only		
		Total	Air	Water	Total	Air	Water
All industries	100,076	4,938	3,176	1,762	1,169	724	444
Manufacturing	38,003	3,153	2,050	1,103	712	446	266
Durable goods	19,389	1,579	1,207	372	321	220	101
Primary metals	3,481	814	712	101	112	82	29
Blast furnace, steel works	1,407	230	163	67	75	56	19
Nonferrous	1,679	523	492	31	29	19	9
Electrical machinery	2,895	129	44	85	35	14	21
Machinery, except electrical	3,478	80	52	28	36	24	12
Transportation equipment	3,063	170	96	74	37	20	1[illegible]
Motor vehicles	2,244	143	81	62	35	19	1[illegible]
Aircraft	531	20	11	10	0	0	0
Stone, clay, & glass	1,503	144	123	22	50	42	8
Other durables	4,969	243	180	63	52	37	15
Nondurable goods	18,614	1,574	843	731	391	226	165
Food including beverage	3,048	152	68	84	49	25	24
Textile	787	29	9	20	11	3	8
Paper	1,893	355	174	181	14	7	7
Chemical	4,324	416	203	213	149	88	61
Petroleum	5,409	555	352	203	151	94	57
Rubber	1,567	48	26	23	12	6	6
Other nondurables	1,586	19	12	7	5	4	1
Nonmanufacturing	62,073	1,785	1,126	659	457	278	179
Mining	2,759	91	41	50	20	15	5
Railroad	1,939	16	5	11	5	3	2
Air transportation	2,413	15	12	4	2	2	0
Other transportation	1,605	11	6	5	4	3	1
Public utilities	19,087	1,451	921	530	386	226	16[illegible]
Electric	16,250	1,409	906	503	372	223	14[illegible]
Gas & other	2,837	42	15	27	14	3	11
Communication, commercial, & other	34,270	201	142	58	41	31	1[illegible]

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, vol. 54, July 1974.

Distribution over Time: In terms of the timing of expenditures, investments are expected to increase steadily up to a peak in 1976 in order to meet the 1971 goals of the Clean Air Act and the Federal Water Pollution Control Act. Annual costs are expected to increase at a rapid rate through 1977 after which they will level off.

Distribution between Investment and O&M Costs: In terms of real resource costs, CEQ estimates that there will be $81.4 billion invested in capital equipment and $121.8 billion spent on operation and maintenance costs over the 10-year period. As noted earlier, this estimate of investment costs is thought to be too high because of the emphasis placed on "end-of-the-pipe" capital investments as opposed to less investment-intensive process charges. The Bureau of Economic Analysis (Department of Commerce) in a recent survey of pollution abatement investments (see Tables II and III) found them to be somewhat lower than the CEQ estimates.[5]

As Tables II and III indicate, the BEA survey provides the first information about the relative importance of process change as opposed to "end-of-the-pipe" treatment for pollution abatement. In 1973 and 1974, 23 percent of the total investment for pollution abatement was expected to be allocated for process changes.

Macroeconomic Impacts

The macroeconomic impacts of environmental expenditures were analysed by CEQ, with the help of the Chase Econometrics, Inc., macroeconomic model.[6]

In 1974, the estimated incremental real resource (investment plus O&M) abatement costs amounted to approximately 0.7 percent of the U.S. Gross National Product. This proportion is expected to increase to approximately 1.4 percent in 1976, and then decrease thereafter as investment costs decrease and GNP continues to grow.

TABLE III
INVESTMENT FOR AIR AND WATER POLLUTION ABATEMENT BY INDUSTRIES, 1974

	Total plant and expenditures	Pollution abatement investment					
		End-of-the-pipe & process change			Process change only		
		Total	Air	Water	Total	Air	Water
All industries	112,114	6,543	4,346	2,196	1,465	1,003	462
Manufacturing	44,404	4,446	2,929	1,517	1,042	721	321
Durable goods	22,611	2,063	1,523	540	499	397	102
Primary metals	4,337	1,003	841	163	250	239	11
Blast furnance, steel works	1,712	381	304	78	114	109	4
Nonferrous	2,156	553	469	83	118	111	6
Electrical machinery	3,179	175	53	122	46	16	30
Machinery, except electrical	3,975	118	74	44	42	27	15
Transportation equipment	3,570	195	112	83	29	17	12
Motor vehicles	2,682	178	103	75	28	17	12
Aircraft	580	13	7	6	0	0	0
Stone, clay, & glass	1,683	282	244	39	58	48	10
Other durables	5,867	290	200	90	73	50	2[illegible]
Nondurable goods	21,793	2,383	1,406	977	543	324	220
Food including beverage	3,276	230	112	118	67	35	32
Textile	773	43	17	26	7	3	4
Paper	2,484	500	326	174	31	16	15
Chemical	5,249	608	293	316	188	109	79
Petroleum	6,888	926	610	316	239	153	86
Rubber	1,580	51	33	18	8	6	2
Other nondurables	1,543	24	16	9	5	2	2
Nonmanufacturing	67,710	2,097	1,418	679	423	283	140
Mining	3,143	100	53	47	28	22	6
Railroad	2,272	19	3	16	3	2	2
Air transportation	2,160	9	4	5	1	0	0
Other transportation	1,617	17	10	7	5	3	2
Public utilities	22,163	1,696	1,179	518	307	200	107
Electric	18,808	1,651	1,160	491	295	197	98
Gas & other	3,355	46	19	27	11	2	9
Communication, commercial, & other	36,355	256	170	87	80	57	23

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business, Vol. 54. July 1974.

Estimated private pollution control investments (excluding mobile sources) amount to approximately 3 percent of gross private domestic investment and 6 percent of business investment in plant and equipment in 1974. These ratios are expected to remain approximately constant through 1976 after which they will fall.

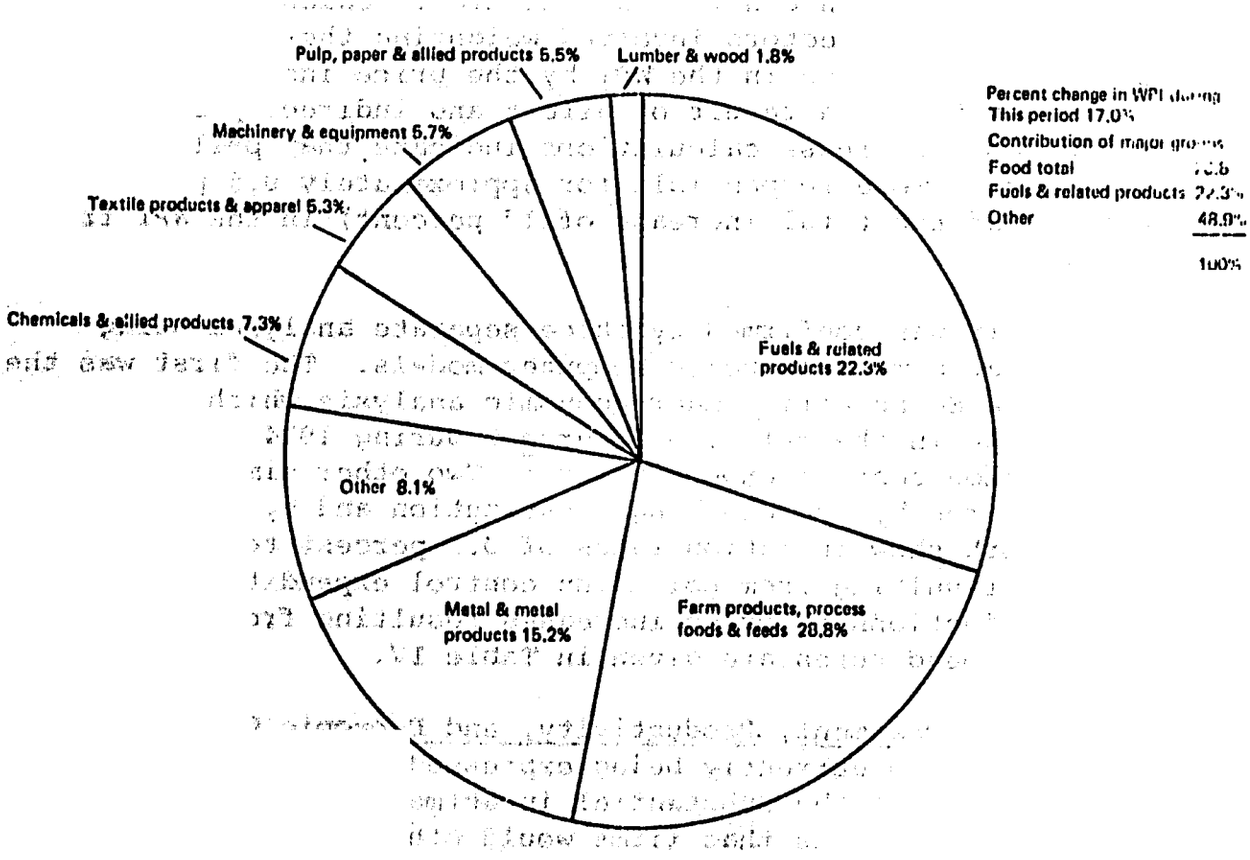
Impact on Inflation: The impact of these expenditures on the rate of inflation has been estimated in two ways. One estimate compares the price increases expected in different economic sectors as a result of pollution control expenditures with the contribution of these expenditures to the rate of inflation. As Figure I indicates, much of the increase in the wholesale price index (WPI) over the past year has occurred because of increased energy (predominantly oil) and food prices. The cost of producing crude oil and unprocessed food is virtually unaffected by pollution control expenditures. Calculating the impact of the remaining sectors involved weighting the contribution of each to the increase in the WPI by the price increase expected in each sector as a result of direct and indirect pollution control costs. These calculations indicate that pollution control expenditures were responsible for approximately 0.5 percent (one-fortieth of the total increase of 17 percent) in the WPI from 1973 to 1974.

This result was confirmed by three separate analyses using sophisticated macroeconomic computer models. The first was the 1973 Chase Econometrics macroeconomic analysis which predicted an increase in the WPI of 0.5 percent during 1974 as a result of pollution control expenditures.[7] Two other similar analyses have been run by the Brookings Institution and by Data Resources, Inc.[8] Both show inflation rates of 0.3 percent to 0.5 percent per year resulting from pollution control expenditures. The Chase projections of price increases resulting from pollution control expenditures are given in Table IV.

Impact on Investment, Productivity, and Economic Growth: One of the concerns currently being expressed about environmental programs is that the substantial investments they require will displace investments that firms would otherwise be making to expand or modernize their production capacity. Such a substitution, if it were to occur widely, could have an adverse impact on the rate of increase in labor productivity because firms

FIGURE I

Percent Contribution to Change in Wholesale Price Index, April 1973-April 1974 (by Major Commodity Groupings)



Source: Cost of Living Council, 1974, based on Bureau of Labor Statistics data.

TABLE IV

PERCENTAGE CONTRIBUTION
OF POLLUTION ABATEMENT EXPENDITURES
TO PROJECTED CHANGES IN PRICE INDICES

	CPI	WPI	GNP deflator
Increase 1975/76	0.5%	2.0%	0.9%
Cumulative increase to 1976	0.8%	2.6%	1.2%
Average increase 1973/76	0.3%	0.9%	0.4%
Increase 1981-82	-0.2%	-0.1%	0.0%
Cumulative increase to 1982	0.3%	2.4%	0.9%
Average increase 1973/82	.03%	0.2%	0.1%

CPI = Consumer price index
WPI = Wholesale price index

Source: Based on Chase Econometrics, Inc., (1974) estimates.

would be operating with older, less productive equipment. And this reduced productivity growth would result in a lower rate of economic growth for the Nation.

The available data indicate that such effects are likely to be minimal. The maximum projected investment for environmental purposes by U.S. industries is unlikely to exceed 6 percent of their total plant and equipment expenditures in any one year, and should average approximately 3 percent of these expenditures over the 10-year estimating period.

The pollution control expenditures will, of course, place increased demands on the capital market and will displace some private investment, but the Chase Econometrics analyses conclude that the displacement will predominantly be in areas other than plant and equipment expenditures, such as residential construction.[9]

This conclusion is at least partially confirmed by the results of the first Bureau of Economic Analysis survey of pollution control expenditures, in which only 2 percent of the firms sampled claimed that pollution control expenditures had displaced any of their planned investments for expanding or modernizing their production capacity.

FIGURE II
Projected Economic Growth, 1974-1982

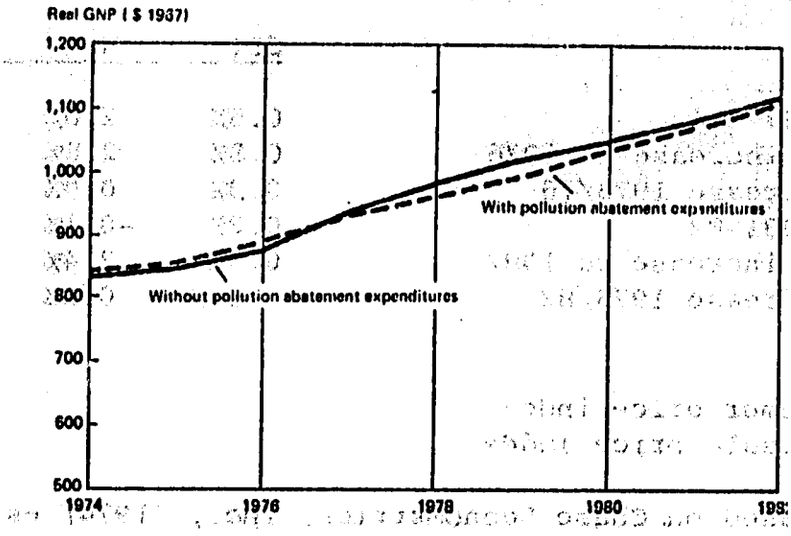
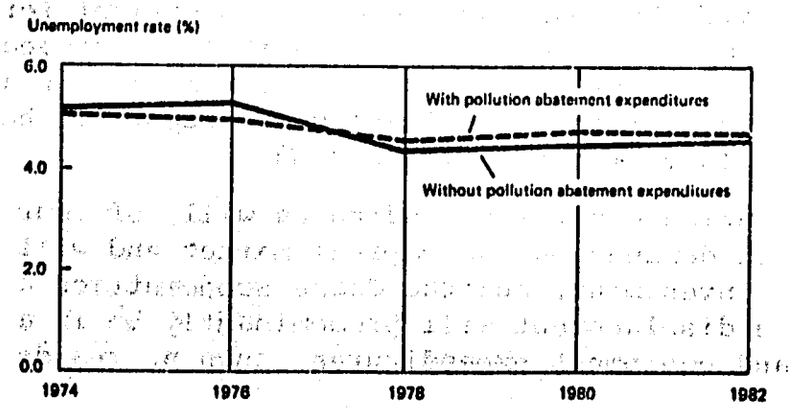


FIGURE III
Projected Unemployment Rates, 1974-1982



The BEA report concluded, "While it is possible that in some industries pollution abatement restrictions have caused a reduction in investment, the low level of positive response to this question indicates that business as a whole does not think of pollution abatement regulations as reducing investment in new plant equipment."[10]

In light of these findings, pollution control expenditures are not expected to delay significantly the expansion or modernization of industrial capacity for producing goods and services, and therefore are not expected to have a measurable adverse impact on labor productivity.

If environmental expenditures have an insignificant impact on plant and equipment expenditures and therefore on productivity, they will have virtually no impact on the rate of growth of the "full employment GNP." However, according to the 10-year forecast by Chase Econometrics, the anticipated peaking of environmentally related expenditures prior to 1978 will create a minor business cycle which will affect the actual growth rate in GNP. These expenditures are expected to stimulate the economy prior to 1976 so that the GNP in current and constant dollars will be higher than it otherwise would have been. After 1976 the slightly higher prices resulting from pollution control expenditures will have a minor depressing effect on the economy, causing the real GNP to dip below the level expected without environmental expenditures. By 1982 this depressing effect is expected to disappear, so that the GNP will be at the same level as it would have been without environmental improvement programs. The projected GNP levels are summarized in Figure II.

Impact on Employment: The impact of environmental expenditures on employment is projected to be insignificant. In the macroeconomic analyses the impact of unemployment is expected to mirror the impact on GNP: before 1976 there will be less unemployment than there otherwise would have been, from 1977 to 1980 there will be somewhat more; but by the end of the decade there will be no significant impact on unemployment. Projected employment rates are given in Figure III.

These macroeconomic analyses do not take account of plant closings caused by environmental regulations, however. EPA, which maintains an "Economic Dislocation Early Warning System" on such closings, had received reports of 69 firms which claimed that they had been

TABLE V

PLANT CLOSINGS WHERE POLLUTION CONTROL COSTS WERE ALLEGED TO BE FACTOR, JANUARY 1971-JUNE 1974

REGION \ INDUSTRY		Paper & allied products	Primary metals	Chemicals & allied products	Food products	Stone, clay, glass & concrete products	Mining & quarrying non-metal minerals	Textile mill products	Other industries	TOTAL
I	Plants	2						3	1	6
	Employees	1,013						-	95	1,108
II	Plants	3	1	3	1		1	1	8	18
	Employees	1,536	44	1,450	102		25	133	1,308	4,598
III	Plants			2	2				3	7
	Employees			610	105				390	1,105
IV	Plants		1	1						2
	Employees		148	78						226
V	Plants	2	5		3	3			1	14
	Employees	500	1,379		165	235			-	2,279
VI	Plants		3						1	4
	Employees		540						45	585
VII	Plants									
	Employees									
VIII	Plants			1			2			3
	Employees			-			208			208
IX	Plants		2		2	2	1		2	8
	Employees		400		-	148	35		529	1,112
X	Plants	3			1				2	6
	Employees	833			38				250	1,121
TOTAL	Plants	10	12	7	9	5	4	4	18	68
	Employees	3,882	2,511	2,138	410	383	268	133	2,617	12,342

1/ Dislocation involving less than 25 jobs is not reported.
2/ "Other industries" includes all dislocations where the combined "actual" and "threatened" plants amount to fewer than six.

Source: Environmental Protection Agency, Office of the Administrator, 1974 Second Quarter Report of the Economic Dislocation Early Warning System.

forced to close plants from January 1971 through June 1974, at least in part because of environmental regulations. These plants represented a total of approximately 12,000 jobs (about .015 percent of the current labor force). The details on these closures are given in Table V.

It should be noted that the increase in unemployment caused by these plant closings will be less than the 12,000 jobs that the plants themselves represented. The lost production will be shifted to other plants, sometimes within the same firm, and as a result more jobs will be created at these other plants. There is probably some net loss in jobs because the plants which increase production are likely to be more efficient than the plants which close. It is the relative inefficiency of these plants -- they are likely to be older, smaller facilities which are only marginally profitable even without the requirement that they install environmental controls -- that leads the firm to conclude that they should be closed rather than modernized. In many instances they would have been closed soon anyway, and environmental regulations tend only to accelerate an otherwise inevitable process.

However, the problem of plant closures should not be understated. As Table V indicates, there is some geographical concentration of the plants which have closed. Many of these plants are also often located in older, industrial towns already suffering relatively high unemployment rates. Their closures can be a serious blow to the local economy and particularly to the workers who may have serious difficulty finding other employment.

Impact on Government Finances: The major sources of government expenditures associated with the implementation of Federal environmental legislation are for municipal sewage treatment plants, solid waste collection and disposal, and air and water pollution abatement from publicly owned facilities. At the Federal level, the EPA sewage treatment grants program has become the second largest public works activity exceeded only by the Federal highway program. Nevertheless, as indicated in Table VI, environmental expenditures still account for only 1.0 percent of total Federal outlays in FY '74 and 1.3 percent in FY '75.

On the state and local levels, because the Federal Government is presently paying a large proportion (up to 75 percent) of the investments required for municipal sewage collection and treatment works, CEQ projects local government environmental expenditures to be lower than they would have been in the absence

TABLE VI

U.S. BUDGET OUTLAYS BY FUNCTION
1973 ACTUAL AND 1974-76 ESTIMATED

[in billions of dollars]

Description	1973 actual	1974 estimate	1975 estimate	1976 estimate
Function:				
National defense	76.0	80.6	87.7	94.8
International affairs & finance	3.0	3.9	4.1	4.3
Space research & technology	3.3	3.2	3.3	3.4
Agriculture & rural development	6.2	4.0	2.7	4.1
NATURAL RESOURCES & ENVIRONMENT	.6	.6	3.1	4.1
Commerce & transportation	13.1	13.5	13.4	13.7
Community development & housing	4.1	5.4	5.7	7.4
Education & manpower	10.2	10.8	11.5	12.3
Health	18.4	23.3	26.3	28.6
Income security	73.1	85.0	100.1	107.2
Veterans benefits & services	12.0	13.3	13.6	13.8
Interest	22.8	27.8	29.1	30.4
General government	5.5	6.8	6.8	6.9
General revenue sharing	6.6	6.1	6.2	6.3
Allowances	--	.3	1.6	4.4
Undistributed intragovernmental transactions	-8.4	-10.0	-10.7	-11.6
Total	246.5	274.7	304.4	329.4

DETAILS FOR NATURAL RESOURCES AND ENVIRONMENT

[in billions of dollars]

	1973 actual	1974 estimate	1975 estimate
Pollution control and abatement	$1.1	$2.6	$4.0
Recreational resources	.6	.8	.8
Water resources and power	2.9	2.9	3.0
Land management	.9	1.0	1.1
Mineral resources	.1	.3	.3
Other natural resource programs	.2	.2	.2
subtotal all programs	5.8	7.8	9.4
Deduction for offsetting receipts	-5.2	-7.2	-6.3
Net total	$0.6	$0.6	$3.1

Source: Office of Management and Budget, The Budget of the United States Government: Fiscal Year 1975 (U.S. Government Printing Office, 1974), p. 86.

of Federal legislation. The fiscal impact of local expenditures will also be reduced by the fact that many of these costs -- e.g., for sewage treatment and solid waste collection -- are likely to be financed out of user charges rather than general revenues.[11]

Impact on Foreign Trade: Analyses conducted by the Department of Commerce, other Federal agencies, and independent analysts have not succeeded in identifying any significant impact of our environmental regulations on our foreign trade and balance of payments.[12] Some U.S. exports will become slightly more expensive, and some imports will become more competitive, but the total effect is small. This is largely attributable to a) the relatively small price increases for U.S. goods as a result of environmental requirements; b) the lack of import competition for many commodities which may experience price increases because of the weight, bulk, or U.S. quality requirements for those goods; and c) the enactment by many competing countries of stringent environmental regulations that will reduce any comparative advantage their industries might have over U.S. firms.

Impact on the Distribution of Income: CEQ and EPA have sponsored studies of the impact of pollution control programs on the distribution of income. These analyses are presently being updated by CEQ.[13] They show that the medium income family paid approximately 0.5 percent of its family income for incremental pollution control expenditures in 1972 in the form of higher products prices, higher tax revenues, and increased service charges for government services. In 1976, this percentage is expected to increase to about 2.0 percent, falling slightly by 1980. In 1976 and 1980 the increased costs are expected to be relatively evenly divided between higher automobile expenditures, higher prices for other goods and services, and higher taxes.

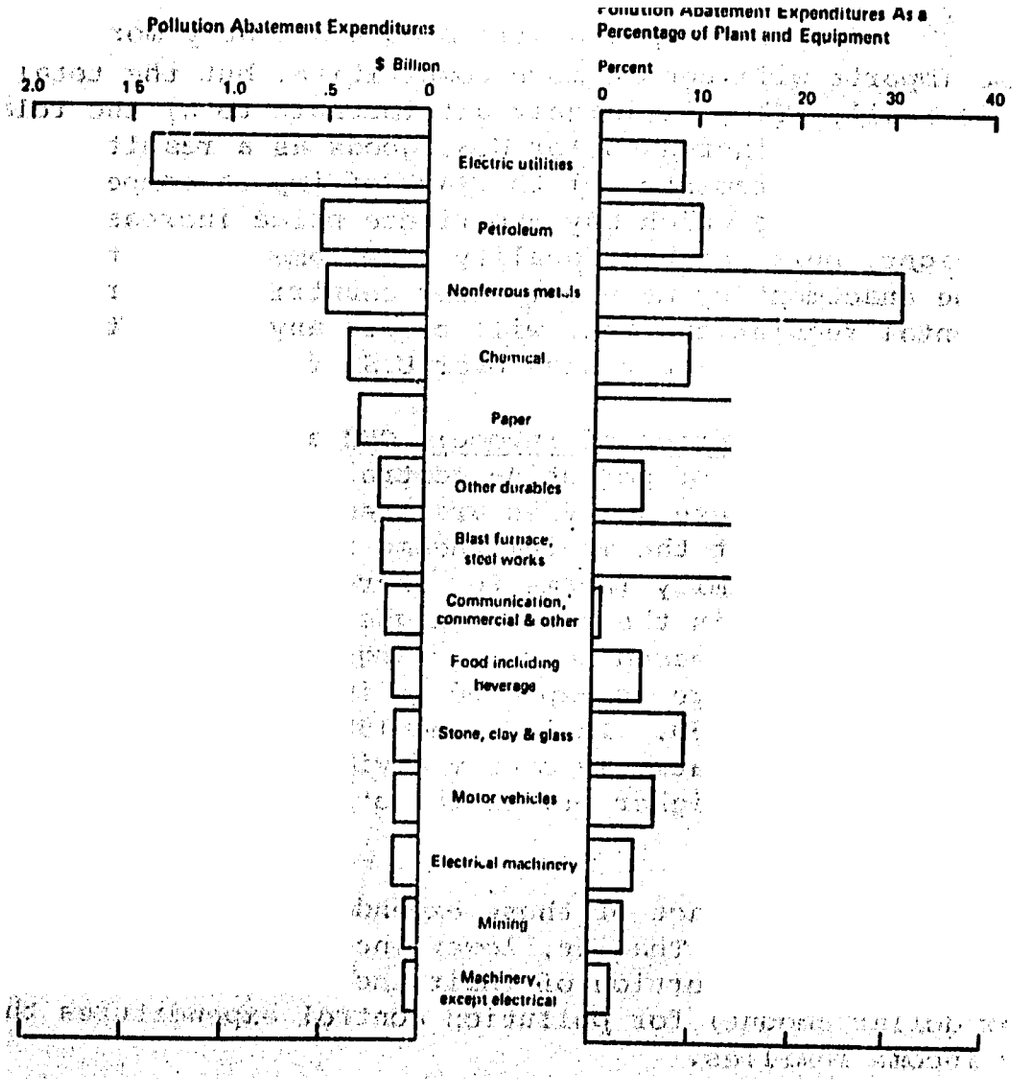
The distributional impact of these expenditures is expected to be mildly regressive. That is, lower income families will pay a slightly higher proportion of their income (although a much smaller dollar amount) for pollution control expenditures than higher income families.

Impacts on Specific Industries

The previous analyses indicated that there was unlikely to be any significant macroeconomic impact of environmental programs. However, the impacts are not spread evenly across all sectors.

FIGURE IV

Pollution Abatement Expenditures for New Plant and Equipment by Selected Industries, 1973



Some industries pollute much more heavily than others and will therefore have to undertake significantly greater efforts to abate their pollution to acceptable levels. Figures IV and V summarize the BEA findings about the relative level of investments being made for pollution control among different industries. Clearly, the industries which would appear to be most significantly affected are:

Electric utilities
Petroleum refining
Iron and steel
Pulp and paper
Nonferrous and primary metals
Stone, clay, glass, and cement
Chemicals
Food and kindred products

These eight industrial groupings account for four-fifths of the total estimated private pollution control investments in 1974. The proportion of total plant and equipment investment spent for pollution control purposes in these industries -- ranging from 10 to 20 percent -- is substantially above the national average -- less than 6 percent. Of course, a high proportion of total plant and equipment expenditures being allocated to pollution control may indicate only that the particular industry is investing relatively little for capacity expansion in the United States.

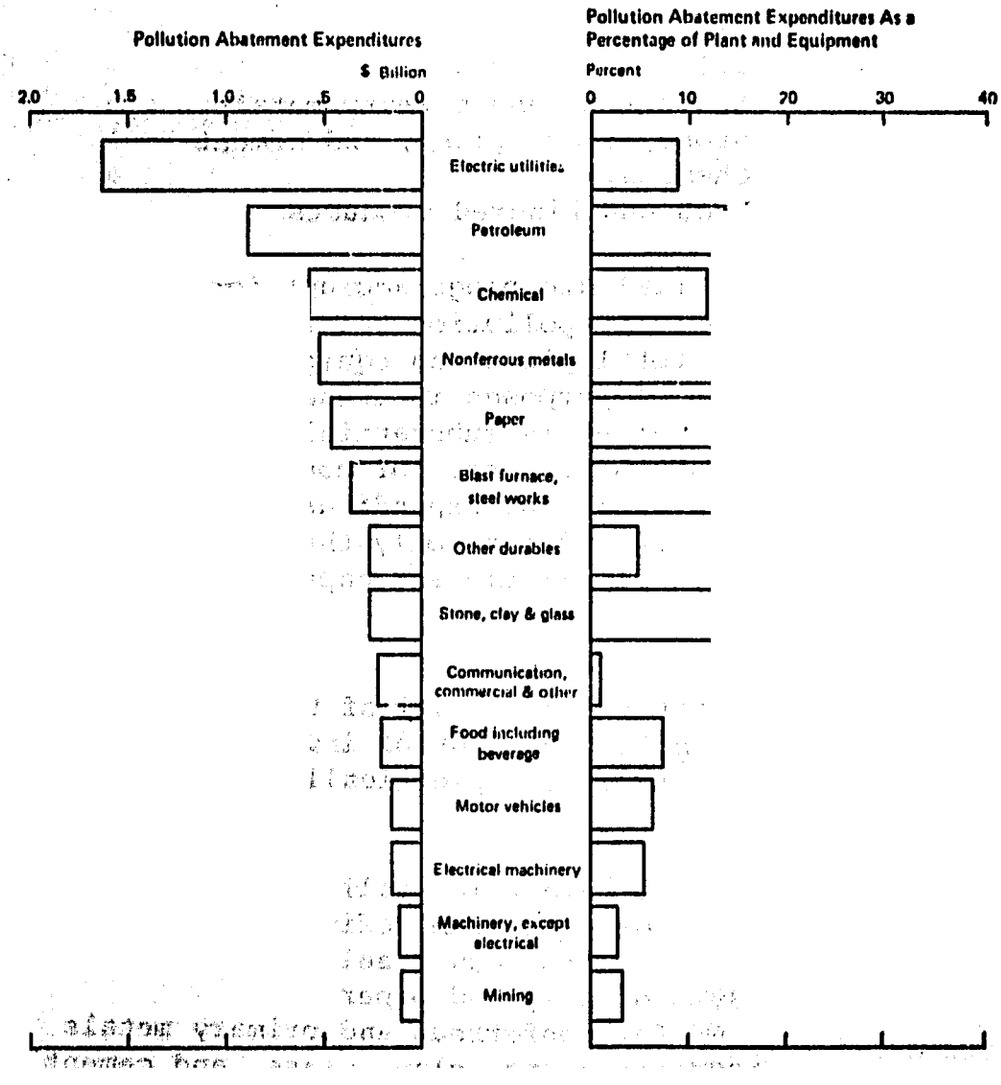
As Tables II and III indicate, all of these industries are expecting to increase their pollution control investments substantially in 1974 over the 1973 levels. Specifically, the expected increase will amount to:

17% for electric utilities
67% for petroleum refining
65% for iron and steel
39% for pulp and paper
6% for nonferrous and primary metals
100% for stone, clay, glass, and cement
20% for chemicals
52% for food and kindred products

CEQ and EPA estimates indicate that these industries will continue to experience relatively heavily pollution control expenditures throughout the decade.

FIGURE V

Pollution Abatement Expenditures for New Plant and Equipment by Selected Industries, 1974



Other important characteristics of the industries are that:

- they are all "basic industries," which means that these price and supply problems ripple through the economy.

- they are generally energy-intensive industries and (excluding electric utilities) account for more than 73 percent of all energy consumed by all industries, and nearly 20 percent of total U.S. energy consumption. In these industries energy is a significant cost element accounting for nearly 14¢ per dollar of value added, compared to the average of all industries of 4¢ per dollar of value added.[13] Therefore these industries face serious cost problems because of high energy prices in addition to the costs added by environmental regulations (see Table VII).

Table VIII, however, indicates that even in those relatively most seriously affected industries, environmental expenditures are not a large proportion of total value added in the industr and therefore should not have a substantial impact upon prices or output.

Such projected increases and output reductions would not normally be cause for alarm. However, because of the importance of these industries to the functioning of the economy, the possibility of very tight capital markets' limiting the availability of investment funds, and in some cases, a recent history of depressed profits, further analysis is clearly required. CEQ and EPA are presently in the process of sponsoring such studies.

TABLE VII

MANUFACTURING ENERGY CONSUMPTION, SELECTED INDUSTRIES, 1967

Industry	Energy consumed per $ of output (MBTU/$)	energy consumption (Trillion Btus)	% Manufacturing Consumption	% U. S. Consumption
Cement	463.0	463	3.1%	0.9%
Petroleum	495.2	2537	17.4	5.0
Metals	250.1	4080	27.9	8.1
Paper	140.1	1156	7.9	2.3
Chemicals	138.3	2460	16.8	4.9
Subtotal		10,596	73.3	21.2
All other manufacturing	20.9	3914	26.7	7.7
Total industrial	(69.7) 1/	14,608	100%	28.9%

1/ Represents the average

Source:
Energy and Environmental Analysis, Inc., "Energy Management in Manufacturing 1967-1990," 1974, prepared for CEQ.

TABLE VIII

POLLUTION CONTROL EXPENDITURES AS A PERCENTAGE OF VALUE OF SHIPMENTS, SELECTED INDUSTRIES, 1973 and 1980

SIC	Industrial sector	Value of shipments ($ million)1/ 1973	Value of shipments ($ million)1/ 1980	Costs2/ as a percentage of value of shipments 1973	Costs2/ as a percentage of value of shipments 1980
26	Paper & pulp	$28,167.4	$39,715.5	0.42%	0.88%
28	Chemical	57,061.5	80,456.7	0.40	0.86
29	Petroleum refining	28,602.2	40,329.1	0.43	0.99
32	Stone, clay & glass	21,430.0	30,216.3	0.25	0.56
33	Primary metals	58,276.5	82,169.9	0.80	2.00
	(Five industry average) →			0.50	1.00
	(All manufacturing average) →			0.20	0.50

1/ 5% annual increase 1973-80.
2/ Calculated on basis of annual costs.

Sources: Value of shipments figures for 1973 are from the Department of Commerce

References

1. See the CEQ annual reports, Environmental Quality-1970; Environmental Quality-1971, Ch. 4; Environmental Quality-1972, Ch. 8; Environmental Quality-1973, Ch. 3: (U.S. Government Printing Office).

2. Environmental Protection Agency, The Cost of Clean Air, Ch. 3: (U.S. Government Printing Office, 1974).

3. Environmental Protection Agency, The Economics of Clean Water-1973 (U.S. Government Printing Office, 1974).

4. A list of items providing a more extended description of data sources and assumptions made in estimating abatement costs appears on page 24.

5. John E. Cremeans, "Capital Expenditures by Business for Air and Water Pollution Abatement, 1973 and Planned 1974," Survey of Current Business, Vol. 54, July 1974), pp. 58-64.

6. Chase Econometric Associates, Inc., "The Economic Impact of Pollution Control," prepared for CEQ and EPA, 1974.

7. Chase Econometric Associates, Inc., "The Economic Impact of Pollution Control: Macroeconomic and Industry Results Executive Summary," prepared for EPA, 1973.

8. Charles L. Schultze and Allen V. Kneese, Pollution: Prices and Public Policy (Washington, D.C.: The Brookings Institution, 1974), to be released in December; and information provided by Charles L. Schultze.

9. The Chase analyses conclude that for every dollar of pollution control investment made, 40¢ of other private domestic investment will be displaced, and most of this displacement will occur in the residential housing sector because it is particularly sensitive to the higher interest rates which would result from increased demands on the capital market.

10. John E. Cremeans, supra note 5, p. 64.

11. The 1972 Amendments to the Federal Water Pollution Control Act, for instance, require industries disposing of their wastes in municipal systems to reimburse the municipality fully for all costs incurred. The municipality will be able to keep out those revenues representing its own expenditures but also some portion of the revenues covering Federal expenditures.

12. Department of Commerce, The Effects of Pollution Abatement on International Trade (U.S. Government Printing Office, 1973 and 1974).

13. Nancy Dorfman and Arthur Snow, "Who Bears the Cost of Pollution Control?" prepared for CEQ and EPA by Public Interest Economics Center, Inc., 1973, available from the National Technical Information Service, Department of Commerce (PB-226 447). The CEQ update is expected soon.

Notes on Methodology

Incremental costs were assumed to equal total costs in the following areas: noise, radiation, land reclamation, utilities, thermal water pollution control, control of air pollution from public sources (solid waste and sewage sludge incineration), and mobile sources.

The selection of the discount rates to be used in amortizing capital costs affects the annual cost estimates. In general, a rate of 8 percent has been used for private investment, 10 percent for mobile sources, and 6 percent for public investment. All three rates are probably below the economists' estimates of the "opportunity costs" of investment funds, and they are below interest rates experienced during the past year. Using these rates tends to understate the financial costs of investments made during such high interest rate periods. However, not all investments are financed by borrowing. The assumption that they all are, which underlies the CEQ cost analyses, tends to overstate the financial costs.

Other Analyses on Economic Impact of Environmental Programs Released by CEQ

Available from the Council*	Date
"Cost of Pollution Abatement" (from 1974 CEQ Annual Report) pp. 173-197	1974
"Calculating Abatement Costs" (from 1974 CEQ Annual Report), pp. 219-226	1974
"The Economic Impact of Pollution Control: Macroeconomic and Industry Reports," by Chase Econometrics, Inc (Executive Summary)	1974
Impact of Pollution Abatement on Income Distribution	1975

Available from the U.S. Government Printing Office	
1973 CEQ Annual Report, Environmental Quality: 1973, "Economics and Environmental Management," Chapter 3, pp. 73-117	1973
1972 CEQ Annual Report, Environmental Quality: 1972, "The Costs and Economic Impacts of Environmental Improvement," Chapter 8, pp. 269-309	1972
1971 CEQ Annual Report, Environmental Quality: 1971, "The Economy and the Environment," Chapter 4, pp. 99-153	1971

The Economic Impact of Pollution Control - A Summary of Recent Studies. Prepared for the Council on Environmental Quality, Department of Commerce, and Environmental Protection Agency. 1972.

CEQ also has a few copies of the results of the BEA survey on pollution abatement costs reprinted from the July 1974 Survey of Current Business.

Available from NTIS*

The Economic Impact of Pollution Control - A Summary of Recent Studies. Prepared for the Council on Environmental Quality, Department of Commerce, and Environmental Protection Agency. 1972. (PB-207 205, $3.75; microfiche, $2.25)

The Economic Impacts of Meeting [Automobile] Exhaust Emission Standards, 1971-1980. Chase Econometric Associates, Inc.
Part I. Executive Summary. (PB-207 200, $3.25; $2.25)
Part II. Baseline Forecasts of Economic Performance. (PB-207 201, $3.75; $2.25)
Part III. The Economic Impact of Pollution Abatement. (PB-207 202, $3.75; $2.25)
Part IV. Appendix. Presentation of Baseline and Alternative Impact Forecasts of Macroeconomic and Industry Performance.
(PB-207 203 $5.75; $2.25)

Analysis of Economic Impacts of Environmental Standards on the Bakery Industry. Ernst & Ernst.
Part I. Executive Summary. (PB-207 169; $3.25; $2.25)
Part II. [A descriptive analysis of the bakery products industry detailing industry trends and characteristics relevant to economic impact analysis of environmental standards]. (PB-207 170, $3.25; $2.25)
Part III. [A study of the impact of pollution standards and charges on the bakery industry]. (PB-207 171, $3.75; $2.25)

The Cement Industry: Economic Impact of Pollution Control Costs. The Boston Consulting Group, Inc.
Volume I. Executive Summary. (PB-207 150, $3.25; $2.25)
Volume II. [Industry description, pollution problems, market structure, financial resources, demand, foreign trade, and employment impact]. (PB-207 151, $7.00; $2.25)

* Prices as of November 15, 1974. Prepaid orders should be sent to the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151.

Possible Impact of Costs of Selected Pollution Control Equipment on the Electric Utility Industry and Certain Power Intensive Consumer Industries. National Economic Research Associates, Inc.
Volume I. Executive Summary. (PB-207 168, $3.25; $2.25)
Volume II. [Introduction, structure of the electric utility industry, and the economic impact of pollution abatement upon the industry and upon selected power intensive consumer industries]. (PB-207 167, $5.25; $2.25)

Economic Impact of Environmental Controls on the Fruits and Vegetable Canning and Freezing Industries. Agri Division, Dunlap and Associates, Inc.
Part I. Executive Summary. (PB-207 140; $3.25; $2.25)
Part II. Industry Structure. (PB-207 141, $5.75; $2.25)
Part III. Impact Analysis. (PB-207 142, $6.25; $2.25)
Part IV. Statistical Supplement. (PB-207 143, $5.75; $2.25)

Study of the Economic Impacts of Pollution Control on the Iron Foundry Industry. A.T. Kearney & Company, Inc.
Part I. Executive Summary. (PB-207 147, $3.25; $2.25)
Part II. The Structure of the Industry. (PB-207 148, $5.25; $2.25)
Part III. The Economic Impact of Pollution Abatement upon the Industry. (PB-207 149, $4.25; $2.25)

The Leather Industry: A Study of the Impact of Pollution Control Costs. Urban Systems Research & Engineering, Inc.
Volume I. Executive Summary. (PB-207 152, $3.75; $2.25)
Volume II. Description of the Industry. (PB-207 153, $6.25; $2.25)
Volume III. Impact of Pollution Control Costs on the Tanning Industry. (PB-207 154, $3.75; $2.25)

The Effects of Pollution Control on the Nonferrous Metals Industries. Charles River Associates Incorporated.

Aluminium: Part I. Introduction and Executive Summary (PB-207 164, $3.75; $2.25)
Part II. Structure of the Industry. (PB-207 165, $5.25; $2.25)
Part III. The Economic Impact of Pollution Abatement on the Industry. (PB-207 166, $3.75; $2.25)

Copper: Part I. Introduction and Executive Summary. (PB-207 161, $3.75; $2.25)
Part II. Structure of the Industry. (PB-207 162, $5.25; $2.25)
Part III. The Economic Impact of Pollution Abatement on the Industry. (PB-207 163, $3.75; $2.25)

Lead: Part I. Introduction and Executive Summary. (PB-207 155, $3.75; $2.25)
Part II. Structure of the Industry. (PB-207 156, $4.75; $2.25)
Part III. The Economic Impact of Pollution Abatement on the Industry. (PB-207 157, $3.75; $2.25)

Zinc: Part I. Introduction and Executive Summary. (PB-207 158, $3.75; $2.25)
Part II. Structure of the Industry. (PB-207 159, $4.75; $2.25)
Part III. The Economic Impact of Pollution Abatement on the Industry. (PB-207 160, $3.75; $2.25)

Economic Impact of Anticipated Paper Industry Pollution-Abatement Costs. Arthur D. Little, Inc.
Part I. Executive Summary. (PB-207 144, $3.25; $2.25)
Part II. Industry Structure. (PB-207 145, $4.25; $2.25)
Part III. Economic Analysis. (PB-207 146, $4.25; $2.25)

The Impact of Costs Associated with New Environmental Standards upon the Petroleum Refining Industry. Stephen Sobotka & Company.
Part I. Executive Summary. (PB-207 197, $3.25; $2.25)
Part II. Structure of the Industry. (PB-207 198, $4.25; $2.25)
Part III. The Impact of Environmental Control Costs. (PB-207 199, $4.25; $2.25)

A study of the Economic Impact on the Steel Industry of the Costs of Meeting Federal Air and Water Pollution Abatement Requirements. Booz-Allen Public Administration Services, Inc.
Volume I. Executive Summary. (PB-211 917, $3.25; $2.25)
Volume II. The Structure of the Steel Industry. (PB-211 918, $5.25; $2.25)
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Volume I, II, III. (PB-211 920, $12.00)

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ENVIRONMENT DIRECTORATE

ENVIRONMENTAL STANDARDS: DEFINITIONS AND THE NEED FOR INTERNATIONAL HARMONIZATION

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

PARIS 1974

ENVIRONMENTAL STANDARDS: DEFINITIONS AND THE NEED FOR INTERNATIONAL HARMONIZATION(1)

PREFACE

1. The Organisation for Economic Co-operation and Development, in carrying out its task of promoting economic development in Member countries, is concerned both with the qualitative and quantitative aspects of economic growth. The Environment Committee of the OECD is responsible for:

(i) investigating the problems of preserving or improving man's environment, with particular reference to their economic and trade implications;

(ii) reviewing and confronting actions taken or proposed in Member countries in the field of environment, together with their economic trade implications;

(iii) proposing solutions for environmental problems that would as far as possible take account of all relevant factors, including cost effectiveness;

(iv) ensuring that the results of environmental investigations can be effectively utilised in the wider framework of the Organisation's work on economic policy and social development.

In the implementation of its mandate, the Committee is assisted by a number of delegate groups concerned with policy development in specific sectors of the overall environment problem. Such groups are established in respect of Air, Water, Chemicals and Urban problems. Co-ordination and development of economic aspects are the responsibility of a Sub-Committee of Economic Experts.

2. This document gives precise definitions of the various environmental standards, describes the factors to be considered in fixing them, and discusses how far it would be desirable to harmonize the standards internationally. On this last point, the document also deals with the lessons to be learned from the Environment Committee's latest reports on pollution control in a number of fields.

3. Attention is drawn to the summary and conclusions of the report which include recommendations as to ways in which emissions of fluorine compounds can be controlled.

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(1) The decision to derestrict the present document was taken on 22nd November, 1974.

10.304

CONTENTS

A. Typology of environmental standards

B. Factors to be considered in fixing environmental standard

C. The problem of harmonizing standards internationally in the light of Member countries' positions

D. Lessons to be learnt from the Environment Committee's latest report

E. Conclusions

Annex: Definitions used by the European Communities and the United Nations.

For the convenience of the reader, the main points in this paper are summed up in the following paragraphs headed "Summary and Conclusions".

SUMMARY AND CONCLUSIONS

(a) Environmental standards, comprising quality standards, emission standards, process standards and product standards, have specific features which distinguish them from one another and from other kinds of standards. Some approach the notion of objectives (quality standards), whereas emission, process and product standards are instruments serving environmental quality objectives. Thus environmental standards are the parameters of a policy, both at target level and at instrument level, and harmonizing them can contribute to harmonizing environmental policies.

(b) Environmental standards are not necessarily uniform throughout the same country, but may vary in many respects from one area to another depending on local conditions and policy aims. This point is illustrated in the reports analysed below(1).

(c) In general, the fact that standards may vary from country to country merely reflects the relative situation of countries and their collective choices. Relative situations are due to the different assimilative capacities of natural environments and to countries' different economic structures and populations, while collective choices reflect relative levels of social preference regarding environmental quality. This point was mentioned in the reports which countries presented at the 6th Session of the Environment Committee.

(d) The fact that standards may vary from country to country does not therefore of itself cause distortion in international trade and in this connection one of the effects of the Polluter-Pays Principle is to preserve relative situations by preventing the creation of artificial situations which might conceal them (see "Guiding Principles concerning International Economic Aspects of Environmental Policies", paragraph 4).

(e) The costs of pollution control depend not only on the level of these standards, but also on such factors as the desirability of recovering materials, wage rates, etc. (see the Report on the Pulp and Paper Industry), so that by applying uniform standards one would not automatically make the costs the same.

(1) Pulp and paper industry, fuel combustion in stationary sources, eutrophication, and motor vehicles.

(f) In view of the foregoing, the international harmonisation of environmental standards raises the following points:

(i) Quality standards

Environmental quality standards are legal constraints which make it possible to achieve or approach given quality objectives defined for an environment. These objectives are always fixed at the appropriate political level according to the kind of pollution to be controlled or the kind of environment to be protected. In fixing them, national, regional, local or international authorities take account of the following factors:

- the basic protection levels.
- the levels of no effects to the environment;
- the specific conditions (ecological, economic, etc.) of the environment concerned;
- possible effects on neighbouring areas;
- the intended use.

(ii) Emission and process standards

It would seem undesirable, as a general rule to harmonis emission and process standards internationally, especial as their nature requires them to be varied according to area. Economic efficiency demands that these standards be suited to local conditions and it would be economically wasteful to impose the same emission standard in areas at different stages of industrialisation and having different populations and environments with different assimilative capacities (see part B and paragraph 31). In practice it often happens that emission standards are fixed case by case within the framework of general directives (the permit system). Moreover, standards change with time, which makes it difficult to harmonise them internationally.

In addition, it is clear that the relationship between the level of standards and the costs of pollution control may vary from one country to another (e.g. in the pulp and paper industry), so that by harmonising standards one does not automatically harmonise costs.

"However, as in the case of quality standards, it would seem desirable to harmonize these standards.

- when there is transfrontier pollution,

- in the case of persistent toxic substances.

(iii) Product Standards

When there is a large volume of trade in the products affected by standards governing their composition, design or use, and where the standards imposed by a country are liable to raise significant non-tariff barriers to trade, the trading partners should consider the desirability of harmonizing these standards taking into consideration environmental and trade constraints altogether(1).

(1) c.f. The Guiding Principles concerning International Economic Aspects of Environmental Policies /C(72)128/.

A. TYPOLOGY OF ENVIRONMENTAL STANDARDS

1. Environmental standards are intended to prevent the harmful effects which pollution of the environment (air, water or soil) may have on health, amenities, activities and natural or man-made assets. These harmful effects are of many kinds and do not relate only to health and well-being. For example, while an air pollution standard may be laid down to protect human health, it may also serve to prevent damage to agriculture (the effect of fluor on maize crops), to protect materials from corrosion, to enable certain industries to operate satisfactorily (e.g. the photographic industry must work in unpolluted air and the food industry requires a certain quality of water) or to preserve natural resources. In some cases water quality standards will be chosen to suit industrial needs and in other cases to suit recreational and tourist requirements involving an aesthetic factor.

These standards may be fixed by legislative authorities at national, regional, or local level and in some cases may be laid down in agreements between industries.

2. In fixing environmental standards, many factors are taken into account, such as the level of industrialisation, population density, social preferences, and the assimilative capacity of the receptor media.

Among these factors are the "criteria" which define "the relationship between the exposure of a target to pollution or nuisance and the risk and/or the magnitude of the adverse or undesirable effect resulting from the exposure in given circumstances" (definition used by the European Communities).

3. One can distinguish four major categories of environmental standards: quality standards, emission standards, process standards and product standards.

Environmental quality standards

4. Environmental quality standards lay down the maximum permissible levels of pollution in the receptor media, namely air, water and soil: for example, organic pollution in a river, the SO_2 content of the atmosphere, DDT in the soil, or the noise level at the front of residential buildings along a traffic artery(1).

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(1) Example:

Air: A SO_2 concentration of 125 microgrammes per cubic metre of air calculated from a 24 hour sample and not to exceed that level for more than 30 per cent of the year.

5. Quality standards cover specific geographical areas and are, for example, national, regional or local. In the same way, a water quality standard may apply to an entire water course or to only a part of it.

6. Environmental quality standards are instruments for achieving or approaching quality objectives. The latter are fixed geographically to suit the kind of pollution to be controlled or the kind of environment to be protected, having regard to a basic protection level, to the use made of the environment and to particular conditions in it. Quality standards should also be set so as to avoid transfrontier pollution.

Emission standards

7. The purpose of emission standards is to specify the quantity of pollutants (or their concentration in effluents) which may be discharged from a given source per unit of time or during a given cycle of operations (e.g. weight of BOD per day for water pollution.)

Emission standards apply to stationary sources (factories and domestic heating).

8. From one point of view it might be more logical to make a finer distinction between stationary and mobile sources by putting in one class the emission and process standards applicable to stationary sources and in another class those applicable to mobile sources, so that one would then speak of the emission standard for a motor vehicle and not of the product standard. In this case the product standard would not affect the emissions and processes connected with the product concerned. The disadvantage of such a narrow definition of a product standard is that it does not clearly distinguish between products which normally enter into international trade and products which do not, so that there would be a danger of confusion if one referred to emission standards applicable to products. Since it seems to be generally agreed that emission and process standards are for stationary sources, i.e. equipment which is not usually traded internationally, it would be better to keep to the wider meaning of product standard which, although not so strict, proves more convenient in use.

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(1) ... continued from page 6.

Drinking water:	maximum of 3 coliforms for 100 ml of water; maximum of 45 mg/l of Nitrates (NO_3)
Noise:	68dBA at the front of residential buildings, not to be exceeded for more than 10 per cent of the time.

Emission standards simply impose an obligation to achieve a result and leave the polluter free to choose how he will comply with it. For example, a paper pulp factory might choose to change its production process or to install water treatment plant. Emission standards, in fact, simply put a quantitative limit on discharges of polluting matter, irrespective of the means used to keep within that limit(1).

9. It should also be noted that emission standards may vary in many respects with time and place. For a given quality objective, an emission standard may vary from one area to another depending on the number of polluters and the assimilative capacity of the environment. A standard may also be temporarily tightened up in an emergency (e.g. in particularly bad weather conditions).

Process standards

10. The purpose of process standards is to lay down, with reference to environmental protection targets, a set of specifications to which stationary sources must conform.

The specifications may consist in standardizing the design, construction and operation of such sources, e.g. by prescribing a certain production process for a factory.

11. Thus, unlike emission standards, process standards impose an obligation to use certain methods and do not leave the polluter free to choose how he will abate his emissions.

12. It should be noted that process standards may prescribe a specific production process, or mode of operation, or type of waste treatment plant.

Product standards

13. Product standards aim at prescribing within various tolerance limits:

(a) the physical or chemical properties of a product (with particular reference to its content of polluting or harmful matter);

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(1) The authorities responsible for emission standards normally fix them to suit certain criteria and the resulting quality objectives, but there remains the problem of how to determine the exact relationship between these criteria, the quality objectives and the emission standards for achieving them, because there are immense difficulties, not yet surmounted, in the way of establishing this relationship.

(b) the rules for making up, packaging or presenting a product so as to ensure consumer protection and make the product identifiable;

(c) the maximum permisssible polluting emissions from the product during its use.

14. It should be noted that product standardization is widespread and serves many purposes, including health safeguards, wholesomeness and public safety. It is often used in industry, when its purpose may be to facilitate mass production and mass consumption and where standards are not usually fixed by public authorities. Some product standards are more particularly intended to protect the environment, but owing to the widespread interaction between environmental protection and public heatth it is not always easy to distinguish between a standard which is specifically for public health and a standard connected with the environment. In the case of food products, for example, the ban on certain additives, colouring matter, preserving agents, etc. is entirely a public health measure and has no connection with protecting the environment. On the other hand, the fixing of maximum amounts of DDT in milk products or of mercury in fish is both a public health measure and an environmental policy measure, since the harmful substances have found their way into these foodstuffs through the environment as a result of an ecological phenomenon, i.e. through the food chain. In the first case the addition of toxic substances to the foodstuffs is deliberate, while in the second case their presence is unintended.

15. A product may also have harmful effects on the environment when it is discharged in the form of solid, liquid or gaseous wastes. This happens, for example, with products containing polychlorinated biphenyls, phosphate detergents or certain packaging materials which cause pollution when they are destroyed The standard then aims at minimising the polluting effects by restricting the use of polychlorinated biphenyls, controlling the biodegradability of detergents, banning certain types of packaging, banning certain pesticides, etc.

16. Lastly, a product may affect the quality of the environment when it is put into use, e.g. the noise and pollution produced by motor vehicles and the noise made by domestic electric appliances.

17. Regulations governing products may take various forms. A standard may specify the composition of a product or what it may emit. It may also take the form of a list of substances whose inclusion in certain products is forbidden (mercury in seeds). Sometimes the regulations dispense with standards and operate through general provisions which, wihhout expressly banning the use of certain substances, empower the authorities to intervene at any moment, or make the marketing of certain types of product subject to prior authorisation.

18. Standardization may include procedures for checking whether products comply with a standard, e.g. the driving cycle for measuring motor vehicle pollution and noise (there is a "European cycle" and an "American cycle").

19. Product standards may be laid down by public authorities, but may also be decided by other bodies, professional or otherwise. Thus the CATT distinguishes between "mandatory standards" imposed by a legal authority and "voluntary standards" which have no legal force.

20. For commercial reasons product standards are often less subject to regional variations because it is important not to have a variety of standards which would handicap the marketing of products and raise costs which would be kept down by mass production. But, for environmental reasons, product standards may be subject to regional variations as, e.g. the sulphur content of fuels or the formulation of detergents.

B. FACTORS TO BE CONSIDERED IN FIXING ENVIRONMENTAL STANDARDS

21. Environmental standards are based on numerous parameters which decide their level and coverage. These parameters include the effects of pollution and disamenities on man, the structure of the environment, social preferences, population structures, economic structures, and the geographical setting.

22. As the criteria are based on scientific data, they should be recognised internationally. They serve as a basis for fixing national standards, and are an indispensible starting point for international harmonization. The fact that they can give rise to standards which vary from country to country is due to differences of environment, of social choice and of economic structure(1).

The structures

23. The environment

Since the quality of the environment depends on its capacity for assimilating pollutants, standards will clearly have to be made to fit this capacity, which is why emission standards may vary from one area to another within the same country. Such area variations mainly affect emission standards, but might also affect product standards to the extent that the products concerned go straight back into the environment or themselves emit pollution.

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(1) For example, different social customs can lead to different degrees of exposure to pollutants. If, for example, a country's feeding habits involve eating twice as much fish containing mercury as another country eats, the first country will require stricter standards for mercury.

24. Social preferences

The fixing of a standard also depends on collective choices made by a country and reflected in a scale of priorities. For example, a country might accept a higher degree or greater risk of pollution for the sake of securing other benefits such as a higher level of employment. It will usually do this by fixing quality objectives for an environment, or part of an environment, to suit the purpose which the environment is intended to serve.

25. Population structure

The degree of exposure to pollution and the likelihood of damage to individuals are connected with the distribution and density of the population in a given territory.

26. Economic structures

Regulations for protecting the environment are only one of the constraints with which an economic transactor has to cope. Production costs are burdened by wage payments, social security contributions and many other factors, whose level may vary from one country to another, so that the relative burden of pollution control may vary between countries, even if the standards are the same.

27. The geographical setting

The fixing of standards assumes a different importance depending on whether they are intended for a geographical area comprising a number of adjacent and relatively similar countries, or for a vaster area comprising largely heterogeneous countries.

Whether at regional or local level, if different quality standards are adopted for two areas on either side of a frontier, the more polluted population may press for its quality standard to be revised upwards with reference to the neighbouring area.

C. THE PROBLEM OF HARMONIZING STANDARDS INTERNATIONALLY IN THE LIGHT OF MEMBER COUNTRIES' POSITIONS

Environmental quality standards

28. As environmental quality standards are by definition instruments for achieving or approaching quality objectives which have been assigned to a given environment, they will be fixed to match these quality objectives. They must be set at the appropriate geographical level.

29. Quality standards thus vary from one country to another or from one area to another.

30. Here, however, there is scope for international co-operation:

(i) for an international control of persistent toxic substances;

(ii) in seeking basic protection levels for the major pollutants, with particular reference to their effects on man;

(iii) when the environment to be protected is common to several countries, and when transfrontier pollution may occur, countries should jointly fix their quality objectives. When several countries decide to join together in an economic and/or political union, there will logically be a certain common basis for determining and implementing the environmental quality objectives.

(iv) when countries implememt programmes to improve environmental quality progressively according to the Guiding Principles which stipulate that "it is desirable to strive towards more stringent standards in order to strengthen environmental protection (paragraph 7)".

Emission standards

31. Emission standards are instruments for reaching a target and if they are to be effective they must be suited to their targets. Consequently, it is natural for emission standards to exhibit many variations depending on the time and place. Even if a quality objective covers the whole of a country, the emission standards may vary from one area to another with local conditions, so that it would probably be economically wasteful to harmonize these standards(1). It is no less clear that the environment is only one of a number of cost factors, or in other words, that the cost of pollution control is only a fraction of an industry's total expenditure, so that even if emission standards were all identical, this would not suffice to make the conditions of competition equal.

32. This problem of the differences between the factors on which standards depend is mentioned in paragraph 6 of the "Guiding Principles concerning International Economic Aspects of Environmental Policies"(2), and paragraph 7 goes on to say that because of these factors "... a very high degree of harmonization of environmental policies which would be otherwise desirable may be difficult to achieve in practice". Whatever type of

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(1) The notion of harmonization assumes a certain measure of agreement without necessarily meaning that the standards are identical. Uniform standards are a particular case of harmonized standards.

(2) C(72)128.

standard is being considered, harmonization accordingly assumes that the parameters are identical, whereas in reality they are divergent.

33. The result is that disparities between standards in different countries and the consequent differences in costs do not of themselves cause distortion in trade, but merely reflect the comparative advantages of different countries. Moreover, it is thanks to these comparative advantages that international trade takes place. Is it not one of the effects of the Polluter-Pays Principle to preserve these comparative advantages by preventing the creation of artificial situations which would conceal them?

34. The Committee would accordingly seem to have agreed that, with certain exceptions, it would not be realistic to try to achieve a systematic general harmonization of emission standards.

35. Where there are transfrontier areas with similar characteristics and problems, the argument in favour of harmonizing quality standards may call for some harmonization of emission standards. Besides, harmonization may be necessary when there are persistent toxic substances, since the stubborn and enduring character of these substances creates a permanent threat of transfrontier pollution.

36. Finally, one may consider that it would be desirable to make technical, economic and financial studies of the industries threatened by distortion of competition, an example of which is the study made of the pulp and paper industry. International co-operation in studying the techniques and costs of pollution control in certain particularly polluting industries could provide a firm basis for the rational management of environmental resources, thus assisting in preventing distortions of competition and might be of value in the consideration of the harmonization of emission and process standards.

Process standards

37. The purpose of process standards is to abate polluting emissions, so that what has already been said about emission standards applies to them also.

However, it may be imagined that the particularly restrictive nature of process standards would make them more difficult to harmonize, since they impose an obligation to use a means rather than to achieve a result.

Because emission standards leave the choice of ways and means free, they provide more flexibility and countries can agree on rates of emission while allowing the use of a whole range of processes for keeping to them.

In certain sectors, however, international co-operation in pollution control techniques could lead to the adoption of common process standards.

Product standards

38. If there is no harmonization, product standards may vary from country to country or from State to State owing to differences between the factors on which they are based.

39. These variations may give rise to non-tariff barriers to trade, when the products concerned enter into international trade, e.g. canned tunny-fish from country A will be refused by country B, if it does not meet the latter's standards or a country will be unable to export its motor vehicles if their emission levels do not comply with the standards in the importing countries. Moreover, it might be very expensive for a producer to have to diversify his products unduly in order to make them fit the requirements of importing countries, so that one might suppose that an international harmonization of product standards would reduce production costs (in large scale plants) and maximise the benefits from international trade. One must also prevent standards from being imposed for protectionist purposes. For all these reasons, various international organisations are trying to harmonize product standards in general, whether they affect the environment or not.

40. As regards the environment, however, the question arises whether measures adopted for reasons of trade policy might not jeopardise the protection of the environment. If, for example, one relaxed a standard for trade reasons, the results might be damaging to the environment.

Other factors which should be assessed are the importance of the relevant products in foreign trade and the adaptability of the various manufacturers, in order to see whether it would be feasible a task to diversify production for export so as to comply with different standards.

41. But, when it is deemed that the differentiation in product standards could lead to significant obstacles to trade, harmonization would be desirable as indicated in paragraph 10 of the Guiding Principles.

42. There is indeed wide agreement in the Environment Committee on the need to consider harmonization of product standards when necessary, taking into account environmental and trade constraints. As it is important to prevent the creation of non-tariff barriers, the harmonization should apply to products in which there is a large trade, and apart from trade considerations, harmonization could be demanded for toxic substances, the use of which is a permanent danger to man and the environment(1).

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(1) In this connection reference may be made to the Decision of the Council on Protection of the Environment by Control of Polychlorinated Biphenyls /C(73)1(Final)/.

D. LESSONS TO BE LEARNT FROM THE ENVIRONMENT COMMITTEE'S LATEST REPORTS

I The Pulp and Paper Industry

Reference: "Pollution by the Pulp and Paper Industry" (OECD - Paris 1973)

43. In the pulp and paper industry the question is whether lessons can be learnt from the report referred to with regard to the possibility and desirability of harmonizing emission and process standards internationally. Product standards are not involved.

The ad hoc Group's Report does not deal with this problem, but instead points out the differences between the situations in different countries.

Diversity of manufacturing processes

44. The report examines the various processes for manufacturing paper pulp with reference to the pollution they cause, and also the processes for controlling the different forms of pollution (water and air pollution). Some processes are more polluting than others and the costs of waste treatment techniques vary with the processes.

45. If, however, the structure of production in the paper pulp industry varies from one country to another with the relative importance of the various processes found in it, this is not because of pollution, but because each process yields a different product. Thus, sulphite pulp is generally used for making newsprint, whereas sulphate pulp is mainly used for making wrapping paper (Kraft paper).

46. Consequently one cannot expect a uniform process to be adopted, since the processes used depend on the pattern of production. Nevertheless some modernisation of sulphite plants is taking place, a number of them being small and out of date.

47. Another trend is the growing proportion of sulphate plants, which is beneficial to the environment to the extent that in treating the liquid effluent a high proportion of materials is recoverable, which makes the treatment less expensive, However, the sulphate process has the disadvantage of polluting the atmosphere more noticeably than other processes, because it emits gas with a pungent, disagreeable smell.

Anyway, it would seem to be neither possible nor desirable to harmonize manufacturing processes.

Diversity of emission standards and costs

48. The report also brings out the disparities in the regulations for controlling pollution in the pulp and paper industry, which include prescribing the best available technology method, the use of uniform miminum standards, case-by-case authorisation, the levying of pollution charges, etc. Furthermore these various regulations are undergoing amendment.

49. Again, emission standards vary from one country to another. The widespread use of a system of case-by-case authorisation to discharge waste makes it particularly difficult to harmonize these standards, since each case, whilst being covered by a set of minimum national standards and/or general guidelines, is treated separately in the light of local economic conditions and the assimilative capacity of the receptor media, so that one wonders whether a harmonization of minimum standards or guidelines would really lead to harmonizing conditions of competition.

50. It should also be noted that agreement on standards is made particularly difficult by the existence of so many different methods of measuring pollution.

51. As there are so many disparities, it is to be expected that the costs of pollution control will vary from one country to another, and indeed they vary greatly (especially as the United States puts the costs considerably higher than the other countries do for the industry as a whole, including sulphate pulp). However, there is much less variation in costs in the sulphate pulp industry, which "has a similar structure throughout the world" (paragraph 369).

52. But differences in standards are not the only cause of disparities in costs. For example, the cost of waste treatment may be considerably affected by the possibility or desirability of recovering heat and energy in the treatment of semi-chemical and sulphite pulp effluent, and whether the recovery of heat and energy will pay or not will depend on the price of energy in the different countries.

Concentration of paper pulp production

53. It should further be noted that it may not be so useful to harmonize standards, because the production of paper pulp is at present concentrated in only a few countries. Indeed, the report says that 77 per cent of the OECD's production of semi-chemical pulp is concentrated in only two countries, while exports were no more than 2 per cent of the total output of pulp in 1970 (paragraph 367). As regards sulphite pulp, four countries share 65 per cent of the production and 86 per cent of the international trade in it (paragraph 368). A bigger part is played in international trade by sulphate pulp, since 20 per cent of the production is exported, representing 67 per cent of total exports of all kinds of pulp (paragraph 370). Nine countries share from 97 to 98 per cent of the total output of sulphate pulp, which in turn accounts for 68 per cent of the production of all kinds of pulp(1).

54. All in all, the report does not seem to justify pleading in favour of an international harmonization of pollution standards in the pulp and paper industry.

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(1) Excluding mechanical pulp.

II. Fuel combustion in stationary sources

References: /1/ "Report and Conclusions of the Joint ad hoc Group on Air Pollution from Fuel Combustion in Stationary Sources" (OECD, Paris, 1973)

/2/ "Recommendation on Guidelines for Action to Reduce Emissions of Sulphur Oxides and Particulate Matter from Fuel Combustion in Stationary Sources - C(74)16 1st Revision"

55. There are two dimensions to the problem of standards for fuel combustion in stationary sources, namely emission and/or process standards, and product standards when the sulphur content of fuel requires them.

56. As in the case of the pulp and paper industry, the Joint Group's report finds a wide variety of policies for controlling air pollution, due to differences in processes, the connection with energy supplies, the rôle of regional planning policy etc. The report therefore stresses the need to adapt policies to local factors (paragraph 43) and the fact that "pollution control strategies should also be different and lead to different priorities in the development of abatement methods" (paragraph 2), so that it is "unlikely that common action throughout the OECD countries will be a satisfying solution" (paragraph 130).

The document /2/ likewise stresses the fact that the different situations in different countries call for 'flexible policies' (appendix).

57. It is accordingly not a question of harmonising standards, but of adopting, if possible, common principles. "It would be very desirable if every country were to use the same conception of air pollution control on which to bases its action" (Joint Group's Report, paragraph 130).

58. Meanwhile, several guidelines are proposed in paper /2/, including recommendation (C) for a degree of standardisation by setting 'maximum limits to the sulphur content of distillation fuels', in which case harmonisation would be applied to a product standard.

59. In addition, it is stressed that States should ensure that their activities do not cause transfrontier pollution.

III. Eutrophication

References: /1/ Report by the Water Management Sector Group on Eutrophication Control (OECD, Paris, 1974)

/2/ Impact of fertilisers and agricultural waste products on the quality of waters (OECD, Paris, 1973)

/3/ Waste water treatment processes for phosphorous and nitrogen removal. (OECD, Paris 1974).

/4/ Report of the Expert Group on Detergents (OECD, Paris, 1973).

/5/ Report on Agreed Projects for Water Supervision as Part of Eutrophication Control - OECD, Paris, 1973.

60. The agricultural sector is involved to a considerable extent in the eutrophication problem, since it is estimated that this sector discharges on average 30 per cent of the phosphorus which is the main cause of the eutrophication of water.

Industry also is involved, because it manufactures detergents which account for some 35 per cent of the phosphorus discharged into water.

Consequently an international harmonization of standards would affect farming practice (but could one then speak of process standards?) and product standards for detergents. (1)

Recommendations regarding processes

61. Eutrophication occurs locally depending on the particular circumstances of each case, which is why the need is repeatedly stressed to adapt the remedies or combinations of remedies to them. Thus report /1/ says that " a wide range of methods of control of eutrophication exists, and Member countries will need to choose the most appropriate combination of solutions which match their particular circumstances" (paragraph 36). In agriculture action should be taken on the same lines (report /2/, paragraph II 41).

62. As a result, the various Expert Groups, after completing their technical studies, have concentrated in their conclusions, on the effectiveness of the different methods of controlling eutrophication. In agriculture a number of recommendations are made regarding the practices to adopt in given circumstances (report /2/) and in its report /1/ the Water Management Sector Group states general conclusions regarding the process of eutrophication and the methods for dealing with it.

63. It is not in fact a matter of harmonizing emission standards. Instead, the Report on Treatment Processes /3/ makes a critical analysis of the different processes and arrives at conclusions with regard to their relative effectiveness. Thus Member countries have a list from which to choose the most suitable processes in the circumstances, and their ability to make a choice based on their joint studies is in itself a starting point for harmonization.

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(1) It should be recalled that 30 per cent is an average and that this value may vary from district to district.

64. Furthermore, certain agricultural practices and industrialised livestock farming processes could perhaps be harmonized, but the reports quoted do not point to this possibility. Here again the studies made on the subject lead to a series of conclusions concerning the effectiveness of a number of different methods which are intended to be combined and applied in varying degrees according to circumstances.

Product standards

65. The Expert Groups have clearly established that the phosphates contained in detergents are an important cause of eutrophication and in this connection the report on detergents /4/ is a valuable guide for finding new formulas for detergents. Without advocating any particular formula, it does at least list the products which should not be used and states clearly the pros and cons of the best substitutes for them, as well as their doubtful features (paragraphs 56 to 93). In addition, as the polluting effect of phosphates depends largely on the "hardness" of the water they are discharged into, the report on detergents /4/ recommends "that the formulation of detergent products should be more closely matched to the hardness of the water in the area of use..." (conclusions, paragraph 10).

66. Perhaps some standardization could be devised on the basis of a limited number of water hardness criteria, but one would have to make sure whether the use of a variety of formulas for detergents would create genuine commercial problems. In point of fact, it seems to be fairly easy to change formulas for detergents at the manufacturing stage, which in any case is usually carried out locally, and international trade is concerned more with the ingredients.

Transfrontier pollution

67. When there is transfrontier pollution it is recommended that, as with fuel combustion, control methods should be harmonized, in this case for controlling eutrophication.

Harmonization of measurement systems

68. It should further be noted that one of the aims of the agreed projects for water supervision /5/ is to "promote a common system of measurements (covering parameters and methods) with which to make valid comparisons of data on surface water eutrophication in different countries" (page 2).

It is certain that a common system of measurements would make it much easier to reach agreement on criteria and standards. Generally speaking, the harmonisation of pollutant monitoring and analysis techniques constitutes an essential basis for any harmonisation effort at the level of standards.

IV. Motor Vehicles

Reference: Environmental implications of options in urban mobility (OECD, Paris 1973).

69. Motor vehicles would seem to be a case in which one might study the problem of harmonizing product standards, in particular with regard to air pollution and noise.

70. The report referred to raises the question whether there should be uniform standards throughout the world (Chapter I). It agrees that in the short term the existing diversity of standards may be explained by differences in environment, climate, levels of car ownership, etc, between countries, but in the long term it detects in most countries a steady trend towards increased urbanisation and motorisation and this common trend could lead to the adoption of common standards by a number of countries.

71. The advantage of common standards would be that non-tariff barriers would be removed and motor vehicle manufacturers would not have to make their vehicles for export comply with numerous different standards, although the long list of costs which manufacturers have to meet would clearly mean that common standards would not by any means make their respective costs equal.

72. The report concludes that "regional harmonization" is required, i.e. "among countries whose environmental conditions and levels of car ownership are similar", and that the general adoption of common standards might follow in the long term.

73. The report also recommends

- that international agreement be sought on adopting uniform test procedures (for measuring pollution and noise;
- that countries should mutually recognise and accept the results they obtain from test measurements of emissions (pollution and noise);
- that the standards for the lead content of motor vehicle fuels should be brought into line.

ANNEX

ENVIRONMENTAL STANDARDS; DEFINITION AND TERMS USED

Definitions used by the United Nations Conference on the Human Environment* and by the World Health Organisation.

- exposure: the amount of a particular physical or chemical agent that reaches the target;

- target: (or receptor): the organism, population or resource to be protected from specified risks;

- risk: the expected frequency of undesirable effects arising from a given exposure to a pollutant;

- criteria: (or exposure-effect relationships): the quantitative relations between the exposure to a pollutant and the risk or magnitude of an undesirable effect under specified circumstances defined by environmental variables and target variables;

- primary protection standard: an accepted maximum level of a pollutant (or its indicator) in the target, or some part thereof, or an accepted maximum intake of a pollutant or nuisance into the target under specified circumstances;

- derived working levels (or limits): maximum acceptable levels of pollutants in specified media other than the target designed to ensure that under specified circumstances a primary protection standard is not exceeded; (derived working levels are known by a variety of names, including environmental or ambient quality standards, maximum permissible limits and maximum allowable concentrations. When derived working levels apply to products such as food or detergents, they may be known as product standards).

- the maximum acceptable release of a pollutant from a given source to a specified medium under specified circumstances may be termed a discharge (or effluent or emission) standard or a release limit. Effluent charges levied on the release of pollutants and materials taxes or price adjustments levied on materials which may become pollutants may also be used to limit the release of pollutants; (in order to meet discharge standards or release limits, it may be necessary to set various types of technological

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* "Identification and Control of Pollutants of Broad International Significance" - A/CONF/48.8, page 44.

standards or codes of practice concerned with the performance and design of those technologies or operations leading to the release of pollutants).

- derived working levels and the various means used to meet them are collectively termed derived standards and other controls;

- action level: the level of a pollutant at which specified emergency counter-measures, such as the seizure and destruction of contaminated materials, evacuation of the local population or closing down the sources of pollution, are to be taken.

B. Definitions used by the European Communities

1. Criteria

1.1. The term "criterion" signifies the relationship between the exposure of a target to pollution or nuisance, and the risk and/or the magnitude of the adverse or undesirable effect resulting from the exposure in given circumstances.

1.2. "Target" means man or any component of the environment actually or potentially exposed to pollution or nuisance.

1.3. The "exposure" of a target, envisaged in this relationship, should be expressed as numerical values of concentration, intensity, duration and frequency.

1.4. "Risk" is the probability of occurrence of adverse or undesirable effects arising from exposure to a pollutant or nuisance considered alone or in combination with others.

1.5. The "adverse or undesirable effect" envisaged in this relationship may be either a direct or indirect, early or late, simple or combined action on a target. The risk and the magnitude of this effect should be expressed, whenever possible, in quantitative terms.

1.6. A harmonization of the methods of evaluating the parameters describing exposure and adverse or undesirable effects should be attempted to ensure the comparability of the results from studies and research on criteria.

2. Quality objectives

2.1. The "quality objective" of a medium refers to the set of requirements which must be fulfilled at a given time, now or in the future, by a given medium or particular part thereof.

2.2 In setting this objective, account may be taken of:

(a) a "basic protection level" such that man or another target is not exposed to any unacceptable risk;

(b) a "no-effect level" such that no identifiable effect will be caused to the target.

These two levels are determined on the basis of the criteria described above.

Account is also taken, where appropriate, of the specific conditions of the regions, of possible effects on neighbouring regions as well as of intended use (1).

3. Environmental protection standards

3.1. "Standards" are established in order to limit or prevent the exposure of targets and may thus constitute the means of achieving or approaching quality objectives. Standards are directly or indirectly addressed to individuals or responsible bodies and set levels of pollution or nuisance that may not be exceeded in a medium, a target, a product, etc. They may be established through legislative, regulatory or administrative action or by means of mutual or voluntary acceptance.

3.2 Standards include:

3.2.1 "Environmental quality standards" which prescribe, with legal force, the levels of pollution or nuisance not to be exceeded in a given environment, medium, or part thereof.

3.2.2 "Product standards" (the term product is used here in its broadest meaning) which:

(a) set levels of pollutants or nuisances not to be exceeded in the composition or in the emissions of a product;

(b) or specify properties or characteristics of design of a product;

(c) or are concerned with the way in which products are used (2).

Product standards may include, where applicable, testing, package marking or labelling specifications.

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1) See item 1.5 of the preceding observations.

2) Such methods of use and specifications may be issued in the form of "codes of practice".

3.2.3 Standards for stationary installations, sometimes called "process standards" such as:

(a) "emission standards" which set levels of pollutants or nuisances not to be exceeded in emissions from stationary installations;

(b) "installation design standards", which determine the requirements to be met in the design and construction of stationary installations in order to protect the environment;

(c) "operating standards", which determine the requirements (1) to be met in the operation of stationary installations in order to protect the environment.

On occasion it may be appropriate to set standards even though related criteria and quality objectives have not yet been formulated.

General

In all instances, as knowledge develops, criteria, objectives, standards and codes of practice will need to be periodically reviewed and, where appropriate, modified.

(1) Such methods of use and specifications may be issued in the form of "codes of practice".

EUROPEAN COMMUNITIES

TERMINOLOGIE EN MATIERE DE PROTECTION DE L'ENVIRONNEMENT
ENVIRONMENTAL PROTECTION TERMINOLOGY

GLOSSAIRE/GLOSSARY

French	English	German	Italian	Dutch
Critère	Criterion	Kriterium	Criterio	Criterium
Cible	Target	Objekt	Bersaglio	Object
Exposition	Exposure	Exposition	Esposizione	Blootstelling
Risque	Risk	Risiko	Rischio	Risico
Effet défacorable ou indésirable	Adverse or undesirable effect	Nachteilige oder unerwünschte Wirkung	Effetto sfacorevole o indesiderabile	Ongunstig of ongewenst effect
Objectif de qualité	Quality objective	Qualitätsziel	Obiettivo di qualità	Doelstelling
Niveau de protection de base	Basic protection level	Basis-Schutz-Niveau	Livello di protezione di base	Basisniveau foor gezondheids-beschermin;
Niveau à effet nul	No-effect level	Null-Effekt-Niveau	Livello a effetto nullo	Effectloos niveau
Normes	Standards	Normen	Norme	Normen
Normes de qualité de l'environnement	Environmental quality standards	Umwelqualitäts-normen	Norme di qualità del l'ambiente	Kwaliteitsnormen inzake het milieu

French	English	German	Italian	Dutch
Normes de produits	Product standards	Produktnormen	Norme di prodotto	Productnormen
Normes de procédés	Process standards	Verfahrensnormen	Norme di procedinento	Procédénormen
Normes d'émission	Emission standards	Emissionsnormen	Norme di emissione	Emissienormen
Normes de conception ou de construction des installations	Installation design	Bauartnormen für Anlagen	Norme di progettazione o di costruzione degli impianti	Conceptnormen en constructienormen voor installaties
Normes d'exploitation	Operating Standards	Betriebsnormen	Norme di utilizzazione	Bedrijfsnormen

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

A REPORT ON MEASUREMENT AND THE QUALITY OF LIFE

and

THE IMPLICATIONS FOR GOVERNMENT ACTION OF THE LIMITS TO GROWTH

January 1973

1-169

FOREWORD

These papers represent a staff response to a series of interrelated questions I have raised, on a number of occasions and in a variety of contexts, about matters that concern all of us. How can we know if the quality of life--the totality of things that really concern us--is improving? How do quality changes in one area relate to changes in another? What effects do government programs have, and how can we change government policies and processes to improve the quality of life? If substantial increases in government intervention into our daily lives are necessary, how can citizens assure treatment responsive to their individual problems? How can we compare quantitatively such effects?

These questions arise most dramatically in the context of current environmental problems, in which we are inevitably forced to trade off some economic output as measured by the GNP to maintain and improve nonmonetary but equally real environmental quality. And an additional part of the trade off lies in the adverse effects of the increase in government bureaucracy and intervention that environmental improvement requires. How do we know what to consider, and how to measure its effects, let alone where to strike a balance? Within and among the areas of health, education, income maintenance, and social services, the same issues arise, albeit somewhat less visibly and dramatically. These questions become even more complex when we consider that our social concerns and how we handle them cannot be divorced from our environmental, economic, and political concerns and policies.

When I asked my staff for help in grappling with these questions, I had hoped that some breakthrough might be possible. These papers argue that this is unlikely, and provide a substantial rationale for their conclusions, which is itself a useful contribution. However, the papers are tentative and exploratory, and cover only a part of the larger set of questions. Because these matters are so important, and to further additional analysis and exploration, I am making the papers available in this form. I hope that others who are concerned with these questions will find them as thought-provoking as I have.

Elliot L. Richardson
Secretary

January, 1973

ACKNOWLEDGMENTS

These papers were prepared in the fall of 1972, in response to a series of concerns that the Secretary of Health, Education, and Welfare raised with the Assistant Secretary for Planning and Evaluation and his staff. The author of both papers was Walton J. Francis, a program analyst in the Office of Planning and Evaluation.

The analysis presented by the papers owes a large debt to a variety of persons who have spent far more time and energy than the author in grappling with the issues they raise, but who are not quoted directly. We especially wish to thank two publishers for their kind permission to reproduce figures from The Limits to Growth, a Potomac Associates Book, by Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William W. Behrens, III, New York: Universe Books, 1972; and "The Socio-Economic Gap," by Michael E. Spautz, Social Science Research, June, 1972.

The papers do not represent completed studies or official positions. They present ideas relevant to the responsibilities of the Department and are circulated for discussion purposes.

CONTENTS

	Page
A REPORT ON MEASUREMENT AND THE QUALITY OF LIFE	
A. Introduction	1
B. Current Efforts to Improve Measuring The Quality of Life	2
C. Conceptual and Practical Difficulties: Generic Approaches	4
1. The National Income and Product Accounts	4
2. "National Social Accounts"	6
3. Social Indicators	6
D. Conceptual and Practical Difficulties: Specific Problems	7
1. Which Direction Is Better?	8
2. How Do We Measure It?	9
3. Measuring It Higher and Enjoying It Less	10
4. Causal Ignorance and Social Indicators	11
5. Mathematical Manipulation and Social Indicators	12
6. The Dangers of Belief	15
E. Conclusions	16
1. Prospects	16
2. Next Steps	17
THE IMPLICATIONS FOR GOVERNMENT ACTION OF THE LIMITS TO GROWTH	
A. Introduction	1
B. The Limits of Limits	2
1. Technology	4
2. Resources	5
3. Pollution	8
4. Costs	11
5. Implications for Growth	12
C. Implications for Government Action	14
1. Growth Policy	14
2. Regulating the Mix of Goods and Services	15
D. Conclusions	17

A REPORT ON MEASUREMENT AND THE QUALITY OF LIFE

A. Introduction

The advances in social statistics and social science over the last hundred years have so facilitated our ability to recognize and diagnose societal problems, and the advances in the hard sciences have so tantalized our aspirations, that our current inability to come to analytic grips with key social issues is almost as frustrating as political and institutional constraints on action. Indeed, breakthroughs in measuring the quality of life might of themselves serve important political purposes by catalyzing attention and action in much the same ways as our most widely used social indicator, the unemployment rate. An only slightly less exalted vision sees such measurements as the key to effectiveness analysis of social programs.

This report explores and attempts to place in perspective the possibility of improving radically the measurement of the quality of life (i.e., of social welfare construed broadly). First, we discuss briefly some recent and current efforts at improvement to set the agenda and institutional stage. Second, we discuss the impediments--some inherent and some surmountable--which plague efforts to make significant progress. Third, we list--without detailed analysis--several possible approaches to changing the intensity or direction of current efforts.

The conclusions which emerge from the report are that:

- There is at present a very substantial effort, both here and abroad, devoted to improving measurement of social conditions and social welfare.

- There is no immediate prospect of a dramatic breakthrough in achieving intellectually respectable broad-gauge measure of the quality of life. The realistic expectation is for gradual improvements in measuring particular problem areas (e.g., health, poverty, environment) rather than any grand synthesis.

- Efforts in this area have been hampered primarily by two factors. First, we are largely ignorant of the causal mechanisms underlying social behavior, and thus of what to measure, and find it difficult to quantify even when we know what we want. This makes the development and linkage of unambiguous quality of life measures extraordinarily difficult. But progress is possible.

Second, we do not have a theoretical basis to aggregate individual measures to enable us to measure objectively whether and to what degree the world is a better place today than yesterday. Progress is not likely since ultimately arbitrary judgments are at stake.

Our report is detailed and its tone negative because it is important, to avoid well-intentioned but unavoidably disappointing efforts, to be aware of the pitfalls in this area. It does not follow, however, that current HEW or Administration efforts should not be expanded or drastically redirected and we present several possibilities in the report.

B. Current Efforts to Improve Measuring the Quality of Life

We have not attempted a comprehensive survey of current efforts. In HEW alone there are numerous past and present examples. The following illustrative items, however, provide some notion of the types of interests and efforts recently completed, now underway, or currently proposed.

In 1969, HEW published an excellent little volume called Toward a Social Report. The Social Report was prepared under the direction of then Deputy Assistant Secretary for Planning and Evaluation, Mancur Olsen, with the advice and help of some of the best social scientists in America.

Toward a Social Report attempted to develop new social indicators and to use both new and old indicators to evaluate social conditions. Of course, existing social indicators are used constantly in a wide variety of analytical contexts and in some sense this effort was of no great profundity, in spite of its substantive merit. Partly for this reason, the Social Report was disappointing to many critics, who found little in the way of new theoretical insights and little progress in development of indicators.

One legacy of the Social Report was a current effort by the Office of Management and Budget, which will publish a compendium of existing social indicators this winter. This effort, however, includes no attempt at analysis or assessment of the data.

Another legacy of the Social Report was the National Goals Research Staff in the White House, whose Toward Balanced Growth (1970) focused largely on discussion of major quality of life issues, with no real attempt to quantify their dimensions.

The National Science Foundation has for about a decade funded social indicator work (now at several million dollars annually) with a major focus on conceptual work and experimental approaches to measuring social change. Starting this fall, NSF is funding a

clearinghouse for social indicator work.

- The Health Services and Mental Health Administration of HEW recently held an informal seminar on population health indices, at which some conceptual progress on several approaches to an overall health index was demonstrated by several researchers. However, the consensus was that a really useful index was about five years off (due to the need to resolve major conceptual questions, design survey instruments, field test and validate, etc.).

- The Council on Environmental Quality and Environmental Protection Agency have efforts underway to develop improved environmental quality data and indices. This is a primitive area at this time, partly because of substantial technical as well as conceptual problems (see "The Quest for Environmental Indices," a chapter in the Third Annual Report of the Council on Environmental Quality). The bulk of the environmental work is now devoted to gathering and interpreting discrete physical data (i.e., comparable to Public Health knowledge of specific disease incidence) rather than developing broad measures of environmental "health."

- The OECD countries, including Japan and the U.S., are jointly developing a standard set of social indicator categories (e.g., health, employment) and measures which will likely lead to OECD publication of international comparisons of such data.

- The Japanese are initiating work on a variety of fronts including improvement of the national income accounts and development of supplementary social indicators. They hope to publish a "net national welfare" index.

- The Senate passed in July of 1972 a "Full Opportunity and National Goals and Priorities Act" (S.5). This act would (among other things) create a Council of Social Advisors, whose principal function would be to prepare a series of social indicators and an annual social report. The Administration testified against this bill last year, principally on the grounds that the state of the art is so primitive that a social report would be premature and perhaps misleading, that the proposed Council would present jurisdictional problems, and that other agencies were already doing much the same things.

One difficulty in expanding such a list is that the borderlines are unclear among separately labeled welfare measurement work, normal efforts at collecting and developing social statistics, ongoing social science research in general, and interpretation of existing social data by analysts. In 1972, the Federal government spent some $200 million on ongoing demographic,

labor, price, production, and national income statistical programs (one-fourth in HEW), not counting the remaining work on the 1970 Census. And most evaluation work involves quality of life measures at least implicitly.

Indeed, the size of the current effort as compared to our lack of apparent breakthroughs is indirect evidence of the intractability and complexity of improving quality of life measurement.

C. Conceptual and Practical Difficulties: Generic Approaches

The following sections discuss both generic approaches (e.g., National Income Accounts) and specific problems (e.g., absence of causal knowledge) in analyzing difficulties in measuring the quality of life. These two organizing principles overlap, but we expect to gain concreteness and clarity at some expense in logical nicety.

1. The National Income and Product Accounts (NIA)

The NIA, by summarizing the diverse economic life of a nation into a consistent set of figures all measured in the common rubric of the dollar, presents a grand achievement in social measurement. Forgotten in the rush to equate increases in GNP with social welfare, and in the criticisms of the "failings" of the GNP, is that the NIA data were not intended to provide measures of social or economic welfare. The NIA, and its most famous single index, the GNP, are instead measures of market activity--of sales and of income--and provide structured data for economic models and macroeconomic policy.

Nonetheless, the NIA measures so much of what a grander vision would encompass that a partial list of its "failings" is both possible and instructive. Government activities are valued at the cost of salaries and other inputs, with no allowance whatsoever made for the value to the consumer of government services. Other non-market "economic" activities, such as leisure, pollution and congestion, are similarly ignored. Peace, freedom, and other "non-economic" values play no role at all. The accounts treat income distribution by counting all dollars equally, whether earned by a Rockefeller or a sharecropper. The outputs of the economic system are measured over time arbitrarily because different mixes of goods and services at different prices present indexing problems soluble only arbitrarily. Most fundamentally, only the most naive utilitarian would equate goods and services or dollar income of consumers directly with psychic satisfaction, yet GNP and other NIA figures are used continually for welfare comparisons which implicitly commit this fallacy.

One possible response to the inadequacies of the NIA as a measure of social welfare is to attempt to substantially improve the coverage of the accounts by incorporating a number of non-market activities not now priced, such as the costs of pollution and the benefits of leisure. One exploratory effort

which does this has just been published by the National Bureau of Economic Research (Economic Growth, by James Tobin and William Nordhaus). This book terms its reestimates unreliable, and disavows any pretense at an all-inclusive welfare measure. Nonetheless, its reestimates are of some interest: the authors' comprehensive measure of the value of household consumption is roughly twice as large per capita as the GNP, but has grown over the past four decades at a somewhat lower rate. The largest single adjustment by far is for leisure, which the authors price (somewhat unrealistically) at the wage rate earners command while at work.

Other economists argue strenuously against trying to "improve" the NIA towards a more comprehensive measure of social welfare (see Arthur Okun, "Social Welfare Has No Price Tag," in the July, 1971, Survey of Current Business). Okun discusses specific difficulties in detail, arguing, for example, that leisure is one of the many good things which do not bear a reasonably determinate price tag. But the core of Okun's argument is that attempts to "improve" the NIA toward a better measure of social welfare might have the misleading and disastrous consequence that the accounts would be increasingly accepted as an all-inclusive welfare measure. In fact, the accounts would still suffer from the insuperable difficulty that human welfare simply cannot be measured objectively in dollars or any other units. Ultimately, all our efforts founder on the essential impossibility of measuring subjective states of mind, and of finding a value-neutral method of adding up "happiness" across people and over time. As Okun says, this is a job for philosopher-kings.

This is not to say that dollar measures cannot be useful approximations to human welfare in specific contexts. It is possible to obtain estimates of what people would be willing to pay, on the margin, to achieve changes in the environment. Such estimates, more or less arbitrarily weighted for income and geographic incidence, can offer more than a little help in justifying the types and costs of pollution control activity which people should bear. But such estimates are of no use in assessing overall social welfare.

Making due allowance for Okun's arguments, we would still conclude that experimental efforts to "improve" the accounts are worthwhile. While the GNP will never be an all-inclusive welfare measure, it might become a better social indicator with minor adjustments or at least better knowledge of what such adjustments would entail. Indeed, if we view the GNP figures modestly, as a particular type of social indicator, there is nothing inappropriate about looking at changes in GNP (i.e., dollar value of goods and services produced) as at least a partial proxy for changes in human welfare. Certainly it would be as naive to ignore material consumption as to make it the apex of human welfare.

In spite of the fundamental defects of the GNP as a measure of welfare, economists are as prone to use it as politicians. Implicitly, the judgment is made that all other things of importance are in fact equal. If we are

able to maintain our environmental, political, and income distribution performances, increases in GNP are not unreasonably taken to mean improvement in the quality of life.

2. "National Social Accounts"

The same fundamental difficulties which preclude the development of the National Income Accounts into true measures of social welfare apply to any alternative scheme of "national social accounts." We can imagine such a scheme metaphysically, and can delineate some of the properties that it should have, such as the possibility of interpersonal aggregation, aggregation across the entire array of life experiences, and reflection of the causal systems which determine social outcomes. This vision remains just that, and no author who has seriously considered the possibility has been able to make any concrete, defensible suggestions as to how to proceed to develop such a system. For example, the GNP weights goods and services by relative prices--what weighting scheme can we use to aggregate freedom, peace and alienation? Proposals founder on the rocks of mysticism, degenerate into arbitrarily weighted aggregates of social indicators, or amount to calls for individual social indicators rather than a single, comprehensive measure of social welfare.

Some authors have weighted individual indicators to form an aggregate measure (see section D.5 below); this is mechanically possible. But even if people agree on desirable directions of change, indicator by indicator, this in no way implies that people agree that the indicators are additive. Doing better on one indicator often means doing worse on another, and even if the model takes this into account, people will disagree on the relative importance of e.g., reducing poverty versus maintaining self-reliance and private consumption. So there is no common rubric independent of the author's prediliction.

This does not mean that arbitrary aggregations cannot have uses. If a summary measure is explicitly presented as illustrative and the sensitivity of the results to alternative weights is clearly demonstrated, this may help people understand and change their valuations. However, even this approach would be misdirected if the causal tradeoffs were not known (see section D.4 below) or if the particular measures involved simply did not capture these relationships. For example who could specify the causal relationships between consumption as measured by the NIA and political participation as measured by voter turnout or voter surveys?

3. Social Indicators

Lowering our vision from a grand scheme which aggregates social welfare in common units, we can seek to devise "social indicators" which measure progress or problems in particular areas of social concern. In Toward a Social Report a social indicator was defined as:

> a statistic of direct normative interest which facilitates..... judgments about the condition of major aspects of a society. It is.....a direct measure of welfare and.....if it changes in the right direction, while other things remain equal..... people are "better off." Thus statistics on the number of doctors or policemen could not be social indicators, whereas figures on health or crime rates could be. (p. 97).

We doubt that any social indicator will ever meet the criterion of "a direct measure of welfare" in the strictest sense. Even ignoring fundamental epistemological issues, we face serious conceptual and practical difficulties.

For example, what is health? A positive feeling of mental and physical well-being, normal functioning in society, or absence of pain and disease? Depending on our definition, we might develop considerably different indicators (e.g., self assessment of well-being on subjective rating scale vs. "objective" counts of disability-free days). Similarly, if we accept disability-free days, how do we measure them--by counting days outside of hospital beds (see Social Report, p. 3) or, as subsequent researchers have proposed, by counting days in which no impairment of normal functioning occurs? The difference is substantial, since Americans average about 2 years of institutional bed disability and 5 years of impaired functioning.

Thus social indicators are often limited proxies for what we really want to measure and, in the narrowest sense, are "mere" social statistics such as "the number of doctors per 1,000 population." Of course, such data can be extraordinarily useful, as in the use of physician visits to measure improved access to health care by the poor, and coliform counts to serve as a measure of potentially harmful micro-organisms in water. But the data are not direct measures of welfare.

A major cause of this reliance on proxies, is, of course, not only conceptual. Some things are just hard to measure, however they are defined. Edward R. Murrow used to say that a cash register doesn't ring when a man changes his mind for freedom. Nor do we have good ways to measure privacy or government responsiveness or a host of other attributes of life quality.

These difficulties mean that lists of social indicators simply do not speak for themselves, independent of context. The very labeling of data as "social indicators," with the normative implications which labeling carries, may be misleading in its implications. Indeed, the omission of items which can not be measured is itself a major bias--often the most important facts about social conditions are qualitative, derivative, or interactive.

D. Conceptual and Practical Difficulties: Specific Problems

In what follows we discuss problems specifically in the context of social

indicators. However, all these difficulties apply to any approach to measuring the quality of life.

1. Which Direction Is Better?

Related to the surrogate nature of most social indicators is the difficulty of interpreting their message simply and unambiguously. Is an increase in the divorce rate a bad thing, because it indicates increasing decay in the family structure, is it a good thing because it means that fewer unhappy couples are forced to stay together, or do we evaluate it at an even higher level and question the very notion of a husband/wife family structure? Is an increase in years of educational attainment a measure of increased skill development, of changing tastes or income availability for consumption, of future discontent as unrealistic aspirations are dashed, or of all three?

The divorce example presents primarily a problem of valuation. People disagree about goals, and social indicators are not value neutral. A Marxist and a businessman might both want to see unemployment go up, because the former believes it hastens the day of revolution, and the latter that it reduces the rate of inflation and disciplines labor unions. Similarly, a little unemployment might be a good thing in most people's view, but a lot intolerable. So which direction is better depends both on where we are, and on our fundamental values. The measure itself is not an "objective" test independent of our beliefs.

The education example presents another problem. The phenomena that indicators measure have many facets, and a single indicator thus represents multiple outputs both good and bad. Some of these outputs are subtle or indirect, and often not well known. Perhaps only a few economists and sociologists fully appreciate the dangers of continued increases in educational attainment for income distribution and social turmoil. And perhaps they are wrong. But the indicator cannot be accepted at face value simply because it is widely perceived to represent an important benefit.

Many examples of indicators ambiguously representing multiple outputs are found in a "White Paper on Living Conditions," published by the Economic Planning Agency of Japan. One indicator used by this document is a measure of "social security" representing the ratio of government income maintenance programs to the GNP. The U.S. ranks low, implicitly because we provide a less adequate income maintenance system than the developed countries to which we are compared. In fact, this measure primarily reflects the American reliance on a progressive income tax, which reduces the need for direct transfers, and the relatively large role of private health insurance in this country. Surely we would not be improving our income maintenance performance if welfare and unemployment payments increased during a recession, or if we raised taxes on lower incomes and had to increase Social

Security and other benefits to leave beneficiaries as well off as before--but our ratio would rise.

2. How Do We Measure It?

Even if we agree on values, and multiple outputs are not a problem, development and interpretation of indicators present substantial conceptual and practical difficulties. Some countries measure unemployment by the number of people visiting state unemployment services, a procedure roughly as valid as measuring crime by reports from the police to the FBI (which we do) or poverty by number of welfare cases (which we do not). In this context, a health index based on deductions for hospital bed days would look worse as we increased access to health services for the poor.

The avoidance of such "institutional" indicators does not prevent foundering. The unemployment rate counts rich teenagers looking for summer jobs in resorts as well as fathers who cannot feed their families. But it omits those so discouraged they have quit searching for work. And the employment and unemployment data omit entirely the dimension of job satisfaction, except as it is reflected (along with other things such as increased opportunities) in high turnover rates. Of course, where we are sensitive to the limits of possible indicators, these deficiencies can be reduced by improving measures and/or careful use for any particular indicator. So one approach is to develop improved indicators.

Sometimes such improvement is difficult. Less widely known but more important than the deficiencies in the unemployment rate are some major biases in our income distribution statistics. For example, independent evidence (such as total unemployment benefits paid) shows that the cash income of the lowest (and highest) income groups is under-reported substantially in the Census and Current Population Surveys. Moreover, certain kinds of income--such as the cash value of Food Stamps and Medicaid--are not counted at all in these surveys. This means that the total number of poor people and the "poverty gap" are exaggerated substantially in the official poverty data. This bias might not matter per se--on the grounds that poverty is relative--except that the most under-reported items have increased especially rapidly in the last decade. Therefore, our trend data are substantially biased over time, and policy decisions concerning such issues as the relative balance between more money versus improved incentives and equities may be distorted. Unfortunately, the conceptual (where should we draw the line on what we count as income?) and practical (how can we correct the data?) problems in improving the data are severe.

But even perfect measurement has its limitations. Our data on annual income are broken out in great demographic detail. These data show that the gap between median black and white incomes decreased substantially on a percentage basis in the 1960's, but increased in terms of absolute

dollars. Depending on their political proclivities, and on the issue at hand, various social commentators use one measure of progress or the other. (The most honest use both if they have space for explanation.) There is simply no unambiguous measure of progress in this area, or probably in any other.

3. Measuring It Higher and Enjoying It Less

One approach to improving measures of the quality c- ---- -- -- -,--- "objective" social indicators and test our progress against subjective perceptions. In some ultimate sense we cannot measure psychic satisfaction directly or satisfactorily. (What does it really mean if two people both tell us they are "very happy"--perhaps one of them has been stunted in aspiration and the other in potential, and does "very" mean the same to both?) But we can elicit states, attitudes and values from public opinion surveys and avoid some of the interpretive problems of the objective counts (though surveys present other dangers--as evidenced by the under-reporting of income). Divorce is good for some people and bad for others--why not just ask?

One serious danger lurking behind the subjective approach was, as usual, described first and best by de Tocqueville.

> The evil which was suffered patiently as inevitable seems unendurable as soon as the idea of escaping from it crosses men's minds. All the abuses then removed call attention to those that remain, and they now appear more galling. The evil, it is true, has become less, but sensibility to it has become more acute. (Quoted in Social Report, p. xii.)

Such a phenomenon may account for much of the malaise of our times (Crane Brinton has argued plausibly that most revolutions occur at times when conditions are improving rapidly, and Schumpeter has argued that the very successes of capitalism will create a class of alienated intellectuals who will destroy capitalism). The problem this phenomenon presents is that all our social indicators might be rising but public disaffection increasing. Is the quality of life, then, rising or falling?

Perhaps the dilemma will not occur. Cantrill's Hopes and Fears of the American People shows that in 1971 virtually all groups in society, including blacks and youth, believed that their personal lot had improved in the 1960's and would improve in the 1970's (the exception is the poor, but since there is substantial turnover in the poverty pool, this probably reflects the problems of those most recently displaced). Yet, seemingly inconsistently, but perhaps reflecting "intellectual" opinion, every single group except blacks believed that the country as a whole had lost ground in the recent past.

4. Causal Ignorance and Social Indicators

Much of this problem of ambiguity of meaning for social indicators, even those which have the most surface plausibility, lies in our lack of understanding of cause and effect in human behavior, particularly over long periods of time and in complicated situations. Even if we had the best imaginable indicator for positive health, how would it be affected by, and relate to, indicators of environmental quality, unemployment and alienation? Since the underlying phenomena are linked in various more or less direct ways, so too are the indicators linked. But what if we cannot measure, let alone understand, the links?

Even in the "simplest" cases we become trapped in causal quagmires. If we plumb black/white income statistics, for example, we become faced with the need to control for age, education, region, family size, and labor force participation to attempt to get a meaningful measure of the residual gap related "solely" to race. This residual itself might be due to discrimination, motivational differences, quality of education or a variety of complicating interactions (e.g., if blacks face discrimination they may rationally restrict their job search, which lowers their exposure to good on-the-job experience, which lowers their future earnings and reinforces black decisions to invest less in education and white decisions to discriminate). Is Moynihan right in calling attention to the income parity that young, married black couples in the north have recently reached with their white counterparts a statistic which implicitly controls many variables, or would a critic be right who emphasized that smaller proportions of young, northern blacks are married couples, and that more of the black wives work?

It is no wonder, then, that as ambitious an attempt at exploring causal linkages as The Limits to Growth has been judged by many critics to be so oversimplified as to be fundamentally misleading. Indeed, the very force of Limits' conclusions derives from its use of supposedly fundamental physical properties, and the model completely ignores the price system, the political system, evolution in values and customs, and other processes of social and economic adjustment. It is as incomplete as models which assume that because the HEW budget goes up, educational attainment of children goes up, ignoring the complicated real world forces which mediate the process. Limits could be viewed as a strictly hypothetical projection rather than a prediction (we doubt, though, that the authors are so modest in intention), but on either interpretation its causal modeling is primitive.

We mention these deficiencies in Limits to illustrate how difficult causal analysis is. Nobody else has a well-developed counter model capable of producing reliable predictions covering the same variables as Limits, let alone a model which deals with broader dimensions of the quality of life.

One example of an area in which even simple feedback loops of the kinds used by Limits could aid our understanding substantially lies in manpower

training, rehabilitation, and job placement. Virtually without exception, no analyst of the benefits and costs of such investments has made a serious attempt to deal with the "displacement" effect--the filling of a job by a newly trained worker may mean that another worker continues unemployed. That this effect occurs to some substantial degree, especially during periods of high unemployment, can scarcely be doubted. And to some extent we may want displacement. The problem is, how much occurs, and under what circumstances, for whom? Unfortunately, standard procedures for evaluating training result in attributing greater net benefits the greater the displacement and the larger the program, since the comparison is with persons who did not receive training or other services--part of the group made worse off. Similarly, the economic benefits of higher education may be due substantially to displacement from better paying jobs of those with only a high school education, regardless of real differences in skills (for an extended argument making this and related points, see Lester Thurow, "Education and Economic Equality," in The Public Interest, Summer, 1972). Of course these problems in no way vitiate the real benefits of training and education--but no one knows even approximately where the balance lies.

As a final example, the Coleman Report's (Equality of Educational Opportunity, 1966) main contributions were to document the lack of measurable inequality of inputs in our schools, to shake naive faith in the benefits of increased educational resources, and to stimulate rethinking of the meaning of "inequality." But even so sophisticated an analysis has misled (primarily through reviewers) innumerable people into believing that its findings imply that socio-economic integration will improve disadvantaged student performance. Perhaps integration will, but statistical correlation does not imply causation (even had the Coleman statistical procedures been fully adequate) and the Coleman Report, like social science research in general, is a very thin reed to rely on.

Lacking such causal knowledge, the validity and usefulness of any set of social indicators (or social statistics) for policy diagnosis becomes suspect. Policy analysis becomes an art rather than a science. Straightforward quantitative measures of progress are inadequate not only because they fail to disclose the underlying processes but also because they may even obscure them.

5. Mathematical Manipulation and Social Indicators

Even if we had the most perfect indicators imaginable, how do we present the numbers? What criteria should guide us? This problem has at least three dimensions--the selection of the indicator, its quantitative presentation, and quantitative procedures used to link it to other indicators. Each presents substantial problems.

One recent effort at measuring the quality of American life illustrates well all these problems (Michael Spautz, "The Socio-Economic Gap," in Social Science Research, June, 1972). The summary indices of this article appear in the figures reproduced below (with permission of the publishers). They look

reasonable. Yet Spautz commits every single fallacy we discuss and his results are capricious (he makes clear in his article that he is aware of the dangers and that his results are illustrative--in which spirit the following criticisms are made).

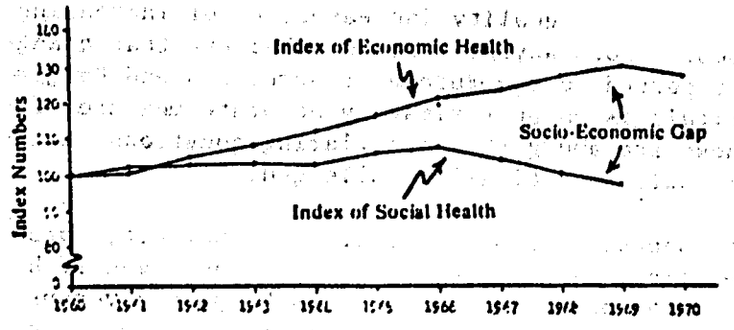


Fig. 1. The Socio-Economic Gap.

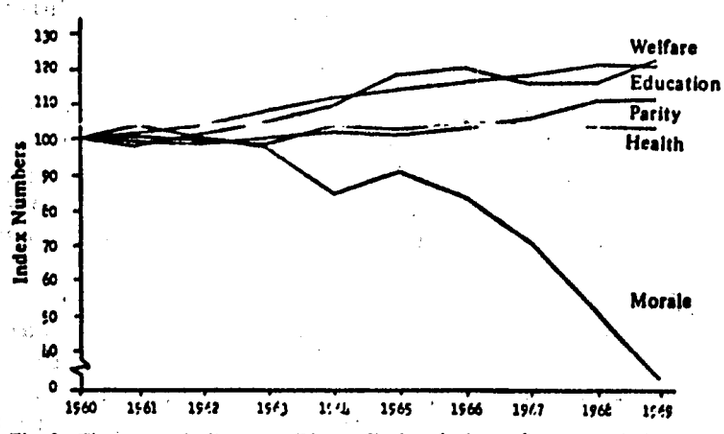


Fig. 2. The Area Indicators. (Note: Each of these five Area Indicators is the arithmetic mean of several components. In turn, the arithmetic mean of the five Area Indicators constitutes the overall Index of Social Health, which is shown in Fig. 1. See Tables 1-3 for numerical data and information on sources.)

Spautz prepares each of his "area" indicators on the basis of a large number of items selected from standard statistical series. It should not be surprising, therefore, that many of his individual indicators stand out for ambiguity or error. Is a big increase in draftees medically disqualified a sign of decreasing health (Spautz), of increasing skill among cooperating lawyers, doctors, and draftees, or of decreasing morale? Is the increasing size of social welfare expenditures (the HEW budget) a measure of welfare (Spautz), of increasing problems, of Parkinson's law, or of anything important

at all? Is the rise in the medical care CPI a measure of decreasing health (Spautz), of our inability to adjust this and other service price indices for subtle quality increases, or of increasing access to health by the poor? Does anyone seriously believe that changes in the number of addicts reported to the Bureau of Narcotics and Dangerious Drugs by police and hospitals is an approximately accurate measure of changes in addiction? While these are among the most glaring questions, every single indicator he picks could be similarly challenged.

But even supposing each indicator were "perfect," problems remain. Spautz has no explicit basis other than expediency (and if he had one, no supportable basis) for the particular indicators he picked versus a larger or smaller number of entirely different indicators. Why not use Cantrill's ladder index of personal satisfaction to measure morale? Why exclude measures of freedom and political participation and thus give these dimensions of life quality a zero weight? Changes in the ratio of social to defense expenditures have been dramatic in recent years, in spite of the war, but surely this duplicates in large part separate indices of defense and social expenditures.

Given an indicator, and a set of raw data for it, how should it be quantified for presentation? Spautz presents indices which show changes each year from a base value of 100, to provide a common format for the data (a procedure which is unobjectionable in itself). But by what mathematical procedure should the data be transformed? Linearly or logarithmically, using the raw data or the data expressed as percentages, or what? To take an extreme case, his work stoppage rate index goes from 100 to 0 because the percentage of days lost from strikes doubled in 9 years. Yet the actual change, from .14% to .28% of worker time lost, could have been expressed as a decrease from 99.86% of to 99.72% of worker time <u>not</u> lost, and the index would have shown a drop from 100 to only 99.9 on this basis.

Finally, in aggregating individual indices to his area and gap indices, Spautz weights each indicator equally. This is a natural and "obvious" procedure, but logically indefensible. Would anyone defend the notion that the percent of the population in the military is exactly as important a measure of "welfare" as the poverty rate, or that economic consumption is as important, alone, as all other aspects of society?

Some of the absurdities could be eliminated. Better measures could be developed. But the inherent arbitrariness would remain. Using different weighting procedures alone, and accepting every other element of Spautz's paper, every single aggregated index could have been shown to decrease substantially. If any single component of the morale index had risen, different weighting could have resulted in the overall morale index rising. The danger is that the better the surface plausibility of the various indicators (i.e., the better each appears to meet the <u>Social Report</u> criterion of "a

direct measure of welfare"), the less obvious would be the arbitrariness of the overall index. In constructing overall indices of social welfare we lack a theoretical basis (such as we might have for black/white income differences) which even allows a point of departure.

6. The Dangers of Belief

Because a set of social indicators, or even a single indicator, is inherently arbitrary it presents a special political danger. We may delude ourselves into believing that the index really measures what it purports to measure. This danger increases in proportion to the claims made or inferred for the indicator--as in the case of the GNP.

This is a danger over and above the normal use or abuse of statistics in the political process, increasing with the honesty, competence, and good will of the authors. For example, the CEQ annual reports question the wisdom of current environmental policies only in the most oblique ways. Special Analyses printed as part of the United States Budget never address the benefits of various social programs, even to the point of admitting our ignorance. Consumer Reports has never told its readers that its automobile ranking system is completely arbitrary nor that very minor changes in weights or test results would change the rankings substantially.

When we consider the need for political expediency together with the probability that those who prepare social indicators will feel impelled to defend their effort, the possibilities for misleading results multiply. One can imagine how a Council of Social Advisors would have wrestled five years ago among more or less apocalyptic versions of social collapse and more or less strident calls for the Great Society. One need hardly guess just how much scholarly investigation or even speculation such a Council would have devoted either then or today to such questions as the effects of the Vietnam War on American morale. One can wonder whether Toward a Social Report could have preserved its objective, analytic tone had it tried to examine critically the effects of HEW programs on various social indicators or attempted an overall assessment of the quality of life. Indeed, Toward a Social Report was originally intended to be a social report without the "Toward." Because of difficulties of the kinds we have been discussing, this ambitious goal was dropped and an explicitly exploratory approach was taken.

The greatest danger comes from committing the easiest sins of all--those of omission. Economists footnote in their texts the dangers of interpreting the GNP as a welfare measure (and sometimes don't even bother since this is taken for granted), but this is much like selling prescriptions without wrap-around labels giving directions for use.

A related danger lies in ignoring things which have not, or can

not, be measured. Virtually every benefit-cost study states in passing that many important outputs are not taken into account because they are non-quantifiable, and defends its approach on the impeccable ground that any reduction in ignorance is useful. What other posture can be taken in a world in which at best we can gain partial understanding? So we ignore displacement, self-respect and alienation, and crime reduction, in a long list of the unmeasured consequences of training programs. The problem, of course, is that a little bit of the truth is sometimes taken for the whole--half right analysis can be worse than none.

These propensities are compounded because truth is contextual--who is to say where to draw the line, and must the universe be surveyed in every statement? Few would argue that the failure of the Census to publish prominently "corrected" estimates of poverty (and of income at the upper end) or at least to suggest the magnitude of error is reasonable, and most would agree that Food Stamps should be counted as if they were cash. But where do we stop--do we insist on counting the cash value of all government services, correcting for tax incidence, and adding in the "value" of leisure? The official definition of poverty is itself arbitrary, as is the decision to use annual average rather than monthly or lifetime income data. The problems are paralyzing, and were we to insist on accuracy, let alone theoretical nicety or contextual "exposure," we would still be waiting for poverty data.

It could be argued that in spite of the inherent pitfalls and inescapable political overtones, social indicator efforts would hardly be likely to leave us worse off than we are now. Surely the Council of Economic Advisors and Council on Environmental Quality have raised the level of economic and environmental debate. The dangers of actively but unintentionally misleading attempts can be coped with--there is rarely a shortage of critics as the authors of The Limits to Growth have discovered. And the need for better assessment of where we are going is patent. But truth does not necessarily win, and the prospect of major advance is small.

E. Conclusions

1. Prospects

Taken together, the preceding analysis of impediments to substantive advance in measuring the quality of life portrays a dismal picture. It is hard to believe, for example, that the Japanese are likely to achieve any striking conceptual success in their attempt to develop a "net national welfare" index (which is not to say that they will not produce some sort of measures). But if the prospects for advance are small, the potential reward is great. Pessimism about success is insufficient reason not to try. (We have deliberately avoided an attempt to enumerate the benefits of success. We believe them to be largely self-evident). But a well-meaning response is not justified simply because a need exists.

We have raised, we are sure, more questions than we have answered. Hopefully, this will at least help in clarifying the nature of our problems. Thus, the limitations in our ability to measure social welfare have implications for our ability to develop effectiveness measures for Federal programs. Effectiveness measures may require not only measures of welfare, but also additional knowledge about the "production process" by which program inputs are translated into impact. We need to know, for example, whether HEW doctor training programs actually increase the supply of doctors (the "number of students aided" is clearly not such a measure), whether the doctors enter practice, and whether increases in practicing doctors improve health. Only the last step requires a measure of health--but not necessarily as perfect or complete a measure of health as we would want for a welfare index. Moreover, if alternative programs would have equally large doctor outputs at lesser cost, then we need not have any measure of health at all to decide on desirable changes. While production and efficiency questions are often as hard as (or inseparable from) output and valuation questions, they at least offer us alternative approaches to particular problem areas.

2. Next Steps

This report is intended to be thought-provoking rather than action forcing. We are not sure where HEW's interest lies, to say nothing of the Federal government's. Therefore, we do not present a considered analysis of possible next steps. Indeed, our current posture of relaxation and monitoring may be the optimal strategy until and unless someone (the Japanese?) makes such a clear advance that the benefits of stepped-up government action of some kind become obvious. This would not be to accept no progress, but would merely recognize that there is no clear, known path as yet to anything grander than marginal improvements in particular problem areas.

Nonetheless, steps are possible. Therefore, we list the following ideas as suggestive possibilities. They are not considered alternatives.

- The government could institute a major, institutional effort (Council of Social Advisors?) at measuring the quality of life, producing an annual Social Report based on existing and newly developed data as well as research and analysis.

- The government could publish something less ambitious. This could range from a socially oriented version of the Statistical Abstract (the Labor Department publishes a Handbook of Labor Statistics but there is no comparable HEW or government-wide document) to a document containing analysis of the data short of an overall assessment.

- The government could institute an official, central clearing house for social indicator and related work to improve information and research sharing.

- Government agencies could jointly or separately attempt to improve the relevance of existing statistical efforts to quality of life measures. Such an effort might be better conceived as part of a more general overhaul of statistical efforts on a variety of fronts, including better exploitation of existing data and filling of gaps.

- Social science research devoted to quality of life measures and underlying causal mechanisms could be expanded. Again, this is only one of a wide variety of issues concerning the size and scope of Federal social science research.

Clearly, each of these possibilities raises a wide range of organizational issues (to say nothing of money--the OMB compendium has only one full-time professional author, which is why this relatively simple compilation effort is taking about three years). Most important, no single agency (existing or proposed) can claim the full scope of responsibility, mission, and competence that the more ambitious efforts would entail.

In lieu of these steps, each of which is substantially oriented towards measurement of quality of life, we could simply improve our research and analysis efforts at discovering and understanding causal relationships and interpreting data in an appropriately sceptical but imaginative fashion. This kind of improvement does not necessarily require more time or effort, but rather more skill and discernment, qualities which are in shorter supply than money, but whose payoff may be much greater. Unfortunately, our knowledge about how to improve the quality of on-going efforts at research and analysis is especially limited.

It would be tempting to suggest that no government or government-supported document concerning social problems or programs be issued without accompanying rebuttals by various critics--but this idea's appeal is exceeded only by its practical shortcomings. Alternatively, authors of such documents could be expected to critique their own work far more than at present. For example, preliminary documents prepared by OECD concerning its social indicator work raise serious questions about the validity and interpretation of possible indicators--will the published documents make the same points? In a larger context, government publication of statistics commonly used in fact (regardless of intention) for social diagnosis would be more valuable if "labeled" with brief discussions of possible bias, problems of causal inference, and possible improvements. Again, it is hard to see how such a change could be brought about.

Whatever steps we take, our problems in developing overall measures need not hamper us in achieving those small advances in ability to diagnose and prescribe which, cumulatively but unmeasurably, mark our progress in improving the quality of life.

THE IMPLICATIONS FOR GOVERNMENT ACTION OF THE LIMITS TO GROWTH

A. Introduction

Only a fool or a madman could fail to recognize the possibility of imminent catastrophe as prophesied in Limits.[1/] The book may have performed a signal service if it provokes action to prevent the horrors it predicts. Perhaps a similar contribution was the most enduring legacy of Marx. But what if Limits is mistaken in its conclusions, and stimulates the government to over-react and drastically and unnecessarily reduce the quality of life? Again, the analogy to Marxism is possible.

This paper explores the possibility that Limits is drastically incorrect in its conclusions, as well as the implications for government action that follow from either Limits' or this paper's diagnosis.

We seek to show, first, that the no-growth implications of the specific computer runs reported in the book are based on assumptions so conservative as to be unreasonable in the extreme. Specifically, the unsupported assertions that pollution and resource use per unit of output can at most be reduced by a factor of four are contradicted by present economic and technical capabilities. These assumptions, in turn, produce the near term catastrophes which give the book its drama.

While the authors purport to present a wide range of alternatives, they do not. Had the authors used a wider range of alternative assumptions, the model could have produced radically different results. Under the more likely assumptions, the average standard of living allowed in what Limits calls a "stabilized world" could be several times the present U.S. level, rather than half the present U.S. level. The direct and indirect implications of this finding for the quality of life for the majority of mankind are, of course, immense.

Second, we briefly explore the implications for government action of both our findings and Limits'. We conclude that neither diagnosis is sufficient grounds for extreme action, but that neither diagnosis is necessary to justify some kinds of action. The question becomes what kinds of actions are best at reducing environmental damage, and what are the full costs of each alternative? We suggest that direct controls over consumption, and bureaucratic planning of production are less desirable than effluent charges and other indirect incentives for pollution control and resource conservation. The key variables affecting this conclusion are such hard to measure dimensions of life quality as consumer freedom to choose, and institutional responsiveness to such choice. Essentially, we must choose between treating people as averages or as individuals, whatever degree of clean-up we want.

1/ The Limits to Growth, A Potomac Associates Book, by D.H. Meadows, D.L. Meadows, J. Randers, and W.W. Behrens, III, New York: Universe Books, 1972. Figures from the book are reproduced below with the permission of the publishers.

B. The Limits of Limits

We wish to criticize Limits on its own grounds, bypassing as much as possible the issues of whether the type of computer simulation modeling used by Limits may or may not be an appropriate or useful computational or analytical technique in addressing "global" economic and social dynamics. Instead, we ask whether reasonable changes in assumptions within the logical confines of the model would change the nature of the results and thus invalidate the conclusions.

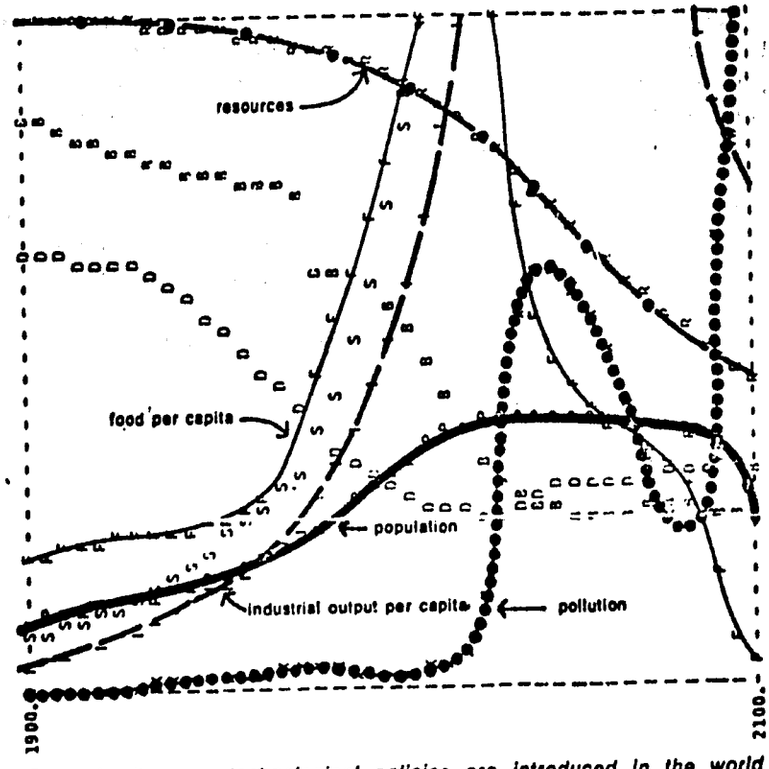
A number of authors have criticized Limits in larger contexts, and on broader grounds, than those we present here.[1/] For example, technologies for expanding resources have been growing exponentially in the past, and Limits' modeling does not capture even the possibility of continuing exponential growth in technology. Similarly, many exponentially growing systems do not lead to catastrophic equilibria, depending on the fine tuning of the mathematic model and/or real world parameters. The plausibility of Limits underlying ideas--food supply does limit population--covers its failure to specify just what the causal relationships are. Finally, Limits simply does not incorporate basic processes of social adjustment such as price changes into its model.

Our more limited agenda and task is complicated by the lack of detailed information--Meadows has not yet published his appendices, and Limits fails to provide numerical scales for its tables. However the task is simplified by the logic that drives Limits--everything depends on the initial assumptions and parameter constraints, with the computer runs themselves necessary only where the feedbacks become excessively complicated. To criticize Meadows' assumptions is to criticize Meadows' results.

To simplify the analysis which follows, we assume that population stabilizes through reduced birth rates to zero population growth or near ZPG. This is a heroic assumption but Limits claims that ZPG does not change its results. ZPG clearly allows sufficient land and food production, so these constraints should disappear and our analysis is simplified. Indeed, Limits shows an incredible rise in per capita food consumption in one of its ZPG scenarios (p. 140, reproduced on next page), which seems to imply a world of obesity. (This apparent anomaly may be explained when the appendices are published, but a reasonable guess would be that Meadows did not impose a constraint on food consumption comparable to, say, present American standards.) In the ZPG scenarios, food production eventually declines but this is due to feedback from the exhaustion of resources (e.g., fertilizers and tractors) necessary to maintain land productivity and/or (unspecified) effects of pollution on land yield.

1/ Among the better critiques are Allen Kneese and Ronald Ridker, "Predicament of Mankind," The Washington Post, March 2, 1972; Peter Passell, Marc Roberts, and Leonard Ross, untitled review, The New York Times Book Review, April 2, 1972; and Carl Kaysen, "The Computer That Printed Out WOLF," Foreign Affairs, July, 1972.

Figure 42 WORLD MODEL WITH "UNLIMITED" RESOURCES, POLLUTION CONTROLS, INCREASED AGRICULTURAL PRODUCTIVITY, AND "PERFECT" BIRTH CONTROL



Four simultaneous technological policies are introduced in the world model in an attempt to avoid the growth-and-collapse behavior of previous runs. Resources are fully exploited, and 75 percent of those used are recycled. Pollution generation is reduced to one-fourth of its 1970 value. Land yields are doubled, and effective methods of birth control are made available to the world population. The result is a temporary achievement of a constant population with a world average income per capita that reaches nearly the present US level. Finally, though, industrial growth is halted, and the death rate rises as resources are depleted, pollution accumulates, and food production declines.

We also simplify our analysis by focusing only on "predictable" events. We do not discuss the risks of unforeseen, "accidental" ecological catastrophes, such as plague or chemical poisoning. Accidental risks, like nuclear war, may be the greatest ones of all (some scholars have argued that the decline of Rome was primarily due to lead poisoning from pipes and pottery glazes). Their diminishment is one of the great possible benefits of the environmental movement (though the FDA has been with us a long time). But Limits does not include these items on its explicit agenda and we shall not either. Similarly, we do not address the substantial probability that serious, localized

disruptions will occur (e.g., a natural gas shortage in the U.S.). Such risks and such disruptions are not directly relevant to the arguments of Limits, until we get to the question of government action.

1. Technology

Imagine a world in which "physical" resources are unlimited but not costless and pollution only a bad dream. This world would still require technological advance to produce per capita growth in output. Such advance would involve, essentially, making more productive the output of human labor through improved education, organization, and ultimately increases in knowledge. There is no reason to believe that such advances can continue forever. In this sense there may well be a limit to growth.

But this limit would not relate specifically to resource exhaustion and pollution as these phenomena are modeled by Meadows. Moreover, no one would argue that we should voluntarily seek such a limit by (say) ending research or limiting innovation. Therefore, to argue that Limits is wrong in its pessimism about pollution control is not to argue that we can grow forever or even that some ultimate limit is unaffected by the costs of pollution control or resource extraction.

In what follows we deliberately commit, along with Limits, the fallacy of ignoring this larger context. This omission is not so fundamental, however, as to cause substantial worry about the next several hundred years. If all the world could reach the output levels of the United States (which itself continues to grow exponentially), we will have substantially exceeded the limits postulated by Meadows. And this achievement seems readily attainable if Limits is incorrect in its assumptions--"growth" policies are hardly unpopular.

The overall drama of Limits is caused by its assertion that it uses in its scenarios "even the most optimistic estimates of the benefits of technology" (p. 145). But these "optimistic" estimates would allow only a quartering of pollution per unit of output (p. 135), and only a quartering of usage rates per unit of output for "scarce" resources (p. 133). The following sections address these specific assumptions.

We are not interested in asserting the inevitability or even the probability of major technological advance either requiring new knowledge (e.g., fusion reactors) or depending on unforeseen, radical applications of "existing" knowledge. Instead, we believe that rather conservative estimates of the potential benefits of existing or immediately foreseeable technology would, if incorporated in Meadows' model, postpone the day of reckoning considerably.

Since the word "technology" has negative connotations, we might be better served by another. However, it is a convenient word and we will use it.

Let us illustrate. Later in the paper we mention solar cells as a source of power. This sounds and is futuristic. To provide electric power with solar cells would require at this time inputs of resources--labor and materials--costing not less than 2 to 4 times at current prices what the same output would require if produced through conventional means (few investigators have paid enough attention to solar power to discover that the common belief that it is 1,000 times as expensive as conventional power is mistaken). But if fossil fuels rise in price sufficiently, solar power would become "economic" and could be used. Lake Mead, if covered by solar cells which can be purchased today, would produce 300 million kilowatt hours of electricity a day, some ten times its current output. To be sure, there are engineering problems involved in widespread use of solar power which would have to be solved. These problems are in some sense comparable to those involved in bringing (say) the steam car into commercial production. But they do not require any fundamental discoveries. Both solar cells and the steam car are roughly as advanced as television was in the 1930's. They are primarily laboratory phenomena far removed from commercial success but presenting no real technological impediments though (as it usually turns out) becoming commercially successful partly because of continued improvements.

In this paper we use no other examples as far out as solar power. But the essential argument is similar even when we consider substituting fiber-glass for steel in auto bodies; or rock wool insulation for gas furnaces in home heating. All these examples depend on changes in prices, production, processes, and possibly consumer habits. Some will occur before others, and some that are technically possible will never occur.

In fact, where we differ from Meadows and company lies entirely (in this paper) in the degree of optimism about such possibilities. We present arguments and examples which have convinced us that a twenty-fold improvement is readily attainable in a growing world economy faced with severe pollution and resource exhaustion problems. We would even regard a hundred-fold improvement as a not unreasonable projection from current knowledge.

Ultimately, this is a matter of probabilities. It is crucial to understand, however, that Limits' computer modeling sheds no light at all on these probabilities, and Meadows' verbal arguments shed very little. Meadows made a judgment that the relevant range for improvement, even including new discoveries, was between zero and four-fold. Given this range, the computer projects near-term disaster. With a broader range, the results would have been substantially different. Our essential argument is that there is a *prima facie* case that Meadows' judgment was unduly restrictive.

2. Resources

The question of resource exhaustion is troublesome since some particular resources of great importance (e.g., natural gas) seem inescapably destined

for exhaustion within a hundred years or so (gas manufactured from coal could extend this time perhaps another century in Limits' exponential world). As a general proposition, however, the notion of physical resource exhaustion is sheer fantasy. The entire mass of the earth is ultimately at our disposal. With sufficient energy (in a world of what we would call technological "optimism") we could tap even diffused metals (e.g., iron rust winding up in sea water) and recycle virtually anything. But the opportunities for reducing use of source materials need not depend on optimism.

The first flaw in Limits' presentation of resource availability is its use of a "known reserves" concept in predicting imminent shortages of many common resources (pp. 56-60). Known reserves is a misleading concept because it is based on reserves which are economic to mine at current prices. Limits says that aluminum reserves will last only 31 years (absent new discoveries). In fact, this estimate is based solely on supplies at current prices and does not take account of the probability that reserves will rise exponentially with arithmetic increases in prices. For example, one currently uneconomic deposit in Wyoming is larger than all the world's bauxite "known reserves" combined (for this and other examples, see Edmund Faltermayer, "Metals: The Warning Signals Are Up," Fortune, October, 1972). While Limits appears to guard against such discoveries by its assumption that there is a 500 year supply, at 1970 usage rates, of all resources (p. 126), this is hardly an optimistic projection. Aluminum makes up 8 percent of the earth's crust, an amount which dwarfs Limits' estimate.

In addition to its "optimistic" assumptions about increases in resource reserves, Limits allows recycling to reduce resource input per unit of output by three-fourths. Thus, Meadows recognizes that as reserves are depleted, prices will rise and make recycling more and more feasible economically. However, even more effective recycling on each pass-through of a product (e.g., reclaim 90% of each auto) could delay the day of resource exhaustion considerably.

Far more important than gross amount of resources or even recycling is substitution of less "scarce" resources for more "scarce" ones. Scarcity is ultimately an economic rather than a physical concept, and substitutes for materials include people and knowledge. We will follow Limits, however, and stick to "physical" examples. Limits did not include sand as a resource. Yet, sand can make cement, ceramics, glass, and fiber-glass, materials which can replace bulk uses of steel, aluminum, and virtually all other metals. Other kinds of substitution are less obviously "technological"--carpooling saves rubber, steel and gasoline; and higher prices reduce use in production and consumption. Since the possibilities for substitution are virtually limitless, any assertion of general scarcity becomes virtually meaningless. Particular items will become scarce and be replaced, and if they cannot be replaced we will do without. Doing without, however, is

not possible in all cases. This is why Limits picked food as a major variable: substitutes for calories are nonexistent. But substitutes for land are not--e.g., greenhouses--and even ZPG is not necessary for ample food.

All resources that we can think of (with the possible exception of fossil fuels--see below) would meet at least one of the following tests: total extractable reserves with current technology but not current prices will last for many thousands of years; an alternative resource meeting the first test is available as a substitute in the production process; or a substitute for the consumption process or good is available. Certainly Meadows presents no counter example. Meadows mentions these criteria (p. 63) and produces examples of violations of the first. But he presents no example of a resource for which there are no substitutes if and when reserves are depleted.

Energy resources provide a major test for our argument. Without fossil fuels (whose expected availability is measurable only in hundreds or at most thousands of years, depending on prices) current energy use patterns are in for traumatic change. And fossil fuel cannot be recycled (except through photosynthesis). Energy has substantial but not endless substitutes--we could well accept that the possibilities for home insulation, walking to work, use of low energy fabricating technologies (e.g., no aluminum) and the like are even more limited than for recycling (which itself may be a substantial energy drain). So will energy become the limiting resource? Not very likely. There are at least tens of thousands of years of uranium reserves. (This depends on breeder reactors. Experimental breeder reactors are already in operation and thus technically feasible, and current research and development is directed at improvements, especially those related to reducing costs.) Solar photovoltaic electric power is now used in a few high-cost applications and if energy prices rise by some multiple (4? 10?) solar cells will be able to provide tens of thousands times current world energy consumption "forever." We need not even consider truly new technology such as fusion.

These examples should show that it is not reasonable to assume that general resource exhaustion will reduce industrial output ever, let alone within a few hundred years. It is in fact probably impossible to document a single physical substance for which we cannot substitute. Presumably Meadows' counterargument would be that substitution requires robbing Peter to pay Paul and that he includes all relevant substitutes. But he does not, as the sand, uranium and solar examples show. Meadows does allow a four-fold reduction in total resources use per unit of output in some scenarios, but this is a trivial concession. The amount of sand, uranium, etc., is thousands of times the quantities of the items listed by Meadows.

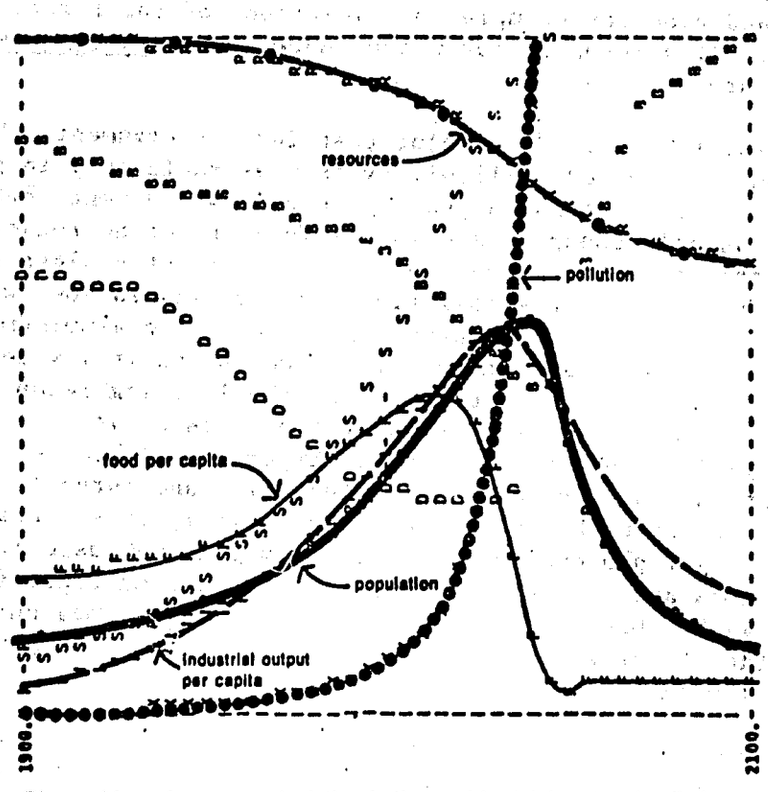
Therefore, we can conclude that reasonable assumptions as to resource

availability could have extended our limits by at least thousands of years, even without new technology. Moreover, in a number of scenarios, Meadows does not show resources as a near-term constraint even with his estimates.

3. Pollution

In several of its scenarios (p. 132, see below) Limits makes some slight provisions for reduced resource utilization (but not, as it claims, provisions that are "more optimistic than realistic"). This scenario controls population by deaths caused by pollution, the other major limiting factor (the cause of death is never specified!).

Figure 37 WORLD MODEL WITH "UNLIMITED" RESOURCES



The problem of resource depletion in the world model system is eliminated by two assumptions: first, that "unlimited" nuclear power will double the resource reserves that can be exploited and, second, that nuclear energy will make extensive programs of recycling and substitution possible. If these changes are the only ones introduced in the system, growth is stopped by rising pollution, as it was in figure 36.

Limits treatment of pollution control is subject to the same criticisms as its treatment of resources. We are able to reach virtual 100% removal of mercury, DDT, radiation, particulates, carbon monoxide, etc., with existing technology (due to lags existing sinks will last in some cases, of course). As a modest example, a switch to steam cars would reduce all auto effluents by 99% or more (the clean-up of the internal combustion engine will probably never be so successful, reaching at most about 90% or 95% at substantial cost, which casts in doubt our current auto air pollution strategy).

We may not even need to improve our current performance in some areas. Limits presents some frightening-looking figures (p. 75) on radioactive emissions but fails to mention that (barring the accidents or war which we have excluded from consideration) the exposure of humans to radiation from nuclear plants will be hundreds of times less than exposure from natural background radiation, to say nothing of x-rays and commercial aviation (a single coast-to-coast flight presents radiation exposure several times greater than a year living beside a nuclear plant).

Limits asserts (p. 135) that particularly intractable problems are presented by thermal pollution, fertilizer runoff, radiation, and asbestos particles from brake linings. Runoff is a tough problem to solve, but is not likely to grow exponentially nor necessarily inimical to human life or production. Thermal pollution is less bothersome than radiation (except for very localized effects) on the basis of arguments which we need not develop here. Asbestos is a classic case: we can eliminate it simply by not using it for brake linings!

Even the currently most intransigent set of effluent problems, associated with water pollution, can be reduced many times by the year 2,000, in spite of an expanding economy, simply by application of current most advanced technology (see table on next page from the 1972 CEQ Report). And these CEQ estimates (which amount, for example, to over a 95% reduction in biochemical oxygen demand per unit of output) make no allowance for substitution in consumption as prices of polluting products rise, or for new technology.

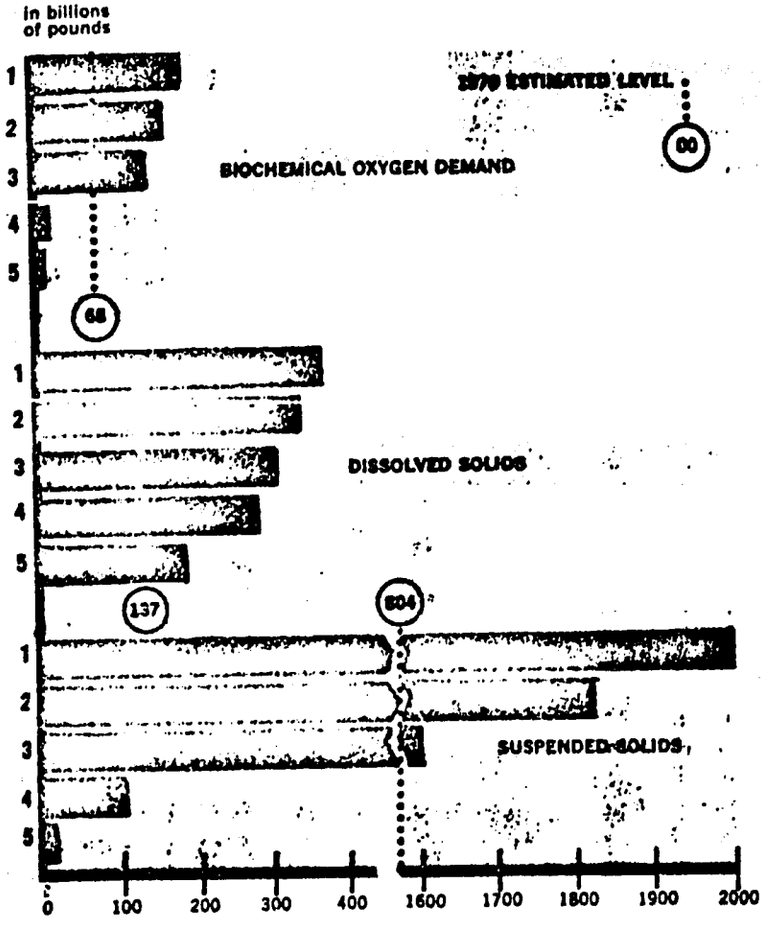
Overall, the probability of successful pollution control on the order of 95% or even 99%, seems much higher than the probability of only 75% or less as assumed by Limits. Since going from 75% to 95% control is actually an 80% reduction in what is left, this is a greater achievement than the simple percentages indicate. But it hardly seems an unlikely achievement or even one requiring a high degree of optimism.

Finally, it should be remembered that it is by no means self-evident that substantially greater amounts of many effluents will in fact be damaging to human beings, directly or indirectly. Limits assumes this to be the

case, and prudence argues for minimizing the risks. But that (say) substantial increases in CO_2 will reduce the habitability of the earth is hardly a known fact. Limits seems to be saying that if one effluent does not get us, another one will. Perhaps, but why not substitute less for more harmful pollutants?

Figure 6

Water Pollution, Year 2000
Under Alternative Assumptions



Assumptions

1. Census Bureau Population projection "B" (3-child family), high GNP($2.6trillion), current levels of waste treatment, current production technology.
2. Same as assumption 1 except Census Bureau projection "E" (2-child family).
3. Same as assumption 1 except production technology equal to current most advanced technology available.
4. Population and GNP assumptions same as #1, secondary treatment of all waste, production technology equal to current most advanced technology available.
5. Same as assumption #4 except assumes advanced treatment (rather than secondary treatment) of all waste.

Sources: Based on data from L. Ayres and I. Gutmanis, "A Model for the Strategic Allocation of Water Pollution Abatement Funds" (1971), prepared for the Brookings Institution; and International Research and Technology Corp., "Effects of Technological Change on, and Environmental Implications of an Input-Output Analysis for the U.S., 1967-2020" (1971), prepared for Reseources for the Future. The Council was assisted by I. Gutmanis in computing this data.

4. Costs

The underlying reason for Limits' pessimism about prospects for resource and pollution improvements is costs, and Limits refers repeatedly to costs as the basis for its assumptions. Limits point is correct abstractly. If we needed solar power to survive, and its installation displaced 100 times the goods and services displaced by conventional power, then our consumption of other goods and services would be drastically reduced. In particular, Limits' argument on pollution control is that it is increasingly expensive on the margin (e.g., the dramatic example given at p. 134 on the costs of controlling water pollution from a sugar beet plant).

But this view is much too simple. Relatively small changes in relative prices may bring about "radical" shifts in production and consumption processes, though such shifts are almost impossible to foresee, and causes and effects are often complicated. If sugar beet plants cannot be cleaned up except at exorbitant cost, then several outcomes are likely in some unknown combination: the price of sugar will rise and consumption will decrease; alternative sources of sugar presenting less intransigent pollution problems will be used; the need for dentists will decrease; and some clever engineer will invent a new process for reducing effluent from beet plants.

We need not be wholly agnostic in these matters, however. Many pollution reduction expenses actually reduce costs. For example, studies have shown that had Albany and other Hudson River cities cleaned up their effluents, New York City could have solved its water crisis and avoided costs several times larger which were incurred in new reservoir construction. Often pollution reduction has been achieved already and is reflected in current costs--nuclear power does not cost less than conventional power partly because we have already built an expensive but effective set of radiation controls. Finally, marginal costs of cleaning up are not always high. The real world includes easy cases as well as the sugar beet cases.

We can be even less abstract. CEQ recently estimated that the incremental cost of meeting existing air, noise, water, radiation, etc., environmental standards over the decade of the 1970's would be about $200 billion (Third Annual Report, p. 281), an amount somewhat less than 2% of expected GNP over the period. These estimates are subject to numerous qualifications (e.g., no allowance is made for substitution in response to changing prices, or for those offsetting benefits which will show up in the GNP), but represent a reasonable, order-of-magnitude estimate. It would be fair in our judgment to say that existing standards represent close to a 75% reduction in pollution per unit of output on an overall basis from levels of the 1960's. (This is so crude as to be ultimately figurative--what is a "unit of output"; three-fourths from what "base"? But Limits uses this terminology and so shall we. A somewhat sounder conception would be to say that "we will reduce volume of pollutants weighted by dollar value of

harm by three-fourths per dollar of GNP.") Some pollutants, such as air emissions, will be reduced somewhat more, others such as water somewhat less. But if this is true this means that Limits' four-fold "optimistic" estimate will have been achieved in one decade at a cost which is if not inconsequential at least not overwhelming.

Since current standards and these estimates are based largely (with the major exception of auto standards) on what is termed sometimes "best practicable technology" rather than "best available technology," to say nothing of substitution or new technology, they understate considerably the potential. Also, necessary costs are overstated because current approaches to air and water standards are in general highly protective of existing industry and require substantial extra costs over the amounts that would be involved if we were willing to accept more temporary dislocation and disruption. These considerations lead us to conclude that Limits' bold assumption that "reduction to less than one-fourth of the present rate of pollution generation is probably unrealistic because of cost" (p. 135) is not warrented.

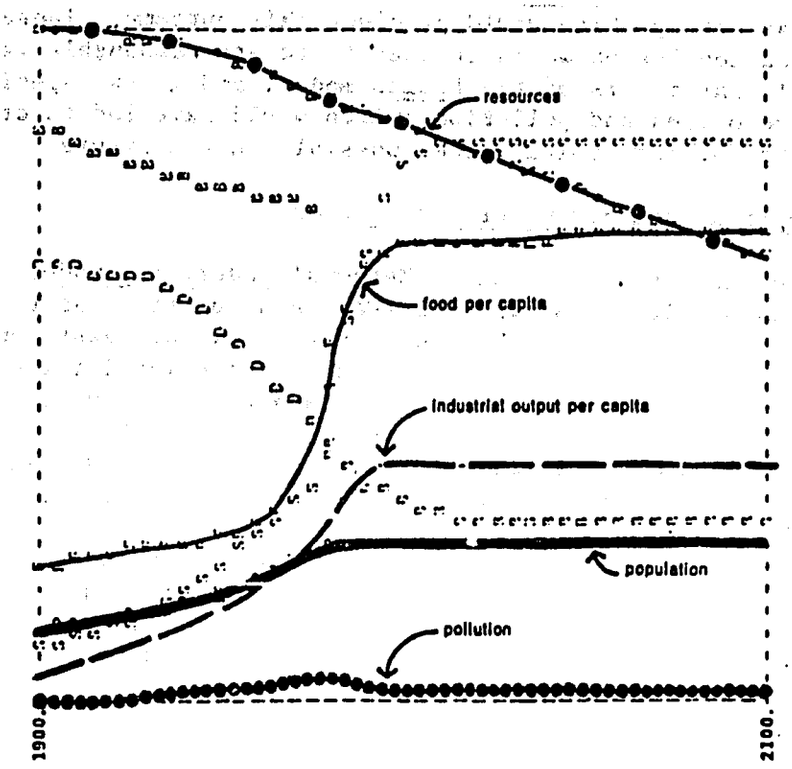
5. Implications for Growth

More important, in the final analysis, than the relative strength of our conclusions versus Limits', is the nature of the dispute. We are not arguing about the century in which crisis will overtake us, or even if the type of modeling used by Limits is reasonable. We are arguing about a set of very complicated factual questions as to the magnitude of the costs necessary to enable economic growth. It is not even really an argument, since Limits presents no real basis for its contrary conclusions. And our side of the "debate" can hardly be considered more than impressionistically inductive. But at the very least we believe that our arguments are sufficient to rebut any presumption in favor of Limits' assumptions and hence conclusions.

Our arguments are largely ones of degree. We believe that Limits is extraordinarily pessimistic rather than optimistic in its assumptions as to current, let alone future capabilities. But even granting that our estimates are more probable, are the authors not correct when they tell us that their results are insensitive to differences in assumptions? They are not. A matter of degree turns out to be of revolutionary importance in terms of results and corollary policy implications.

Limits itself presents a run (p. 165, see next page) in which the world does not end by 2100 or any time soon thereafter (though it implies an eventual crisis as resources are depleted). But in this run industrial output for the world as a whole is sharply curtailed and grows to only half the present U.S. average. If Limits is extraordinarily pessimistic about existing capabilities, this scenario becomes extraordinarily misleading. Suppose that we could measure improved resource utilization and pollution control capabilities in terms of Limits' model, and that the attainable improvements

Figure 46 STABILIZED WORLD MODEL I



Technological policies are added to the growth-regulating policies of the previous run to produce an equilibrium state sustainable far into the future. Technological policies include resource recycling, pollution control devices, increased lifetime of all forms of capital, and methods to restore eroded and infertile soil. Value changes include increased emphasis on food and services rather than on industrial production. As in figure 45, births are set equal to deaths and industrial capital investment equal to capital depreciation. Equilibrium value of industrial output per capita is three times the 1970 world average.

we have discussed were twenty-fold rather than four-fold (i.e., 95% rather than 75%). It appears to us that this would allow about a five-fold increase in industrial and food outputs over Limits' estimates. But a five-fold increase in per capita income means that the entire world (on the average) would rise to 2 1/2 times the present U.S. level. This by no means optimistic assumption implies the exact opposite of no-growth policies.

Unfortunately, it is difficult to be sure if this conclusion would follow

automatically, from a five-fold reduction in the constraints imposed by pollution and resources, without a new set of calculations from Limits' computer. Our conclusion seems consistent with the behavior of the computer runs presented in Limits, but there may be some arbitrary feature of the model as set up which would preclude this outcome. Therefore, a more tempered conclusion would be that there are reasonable variations in the specific parameters of the Limits model, and in the specific assumptions about resources and pollution, which would have led to dramatically increased estimates of per capita income possible in the future.

C. Implications For Government Action

We have shown that nothing in Meadows' underlying model requires catastrophe. More reasonable but still conservative assumptions as to use of existing technology and substitution would have shown at least some possible beneficial futures. But some futures, especially those involving high population growth, would still be bleak. Bangladesh is here now. The possibility of substantial disruption, to say nothing of "accidental" (i.e., non-assumable) events, is always present. Most important, the assumptions used are really conclusions. Nothing ordains even a quartering of pollution.

Therefore, while Limits does not prove the case for government action to halt growth, it in no way obviates it. Despite its claims, Limits is not surely correct. Indeed, it is almost surely incorrect insofar as it relates to the 22nd century. But our fate should not depend on glib projections either way.

1. Growth Policy

What should be done? Here we must part company with Limits' policy prognosis. For Limits implies that the government should act now to reduce growth, and act now to impose strict discharge controls (never mind that clean-up requires growth!). This presents a serious set of moral and political problems for it would be intolerable to leave three-fourths of the world's population in poverty forever. So we must redistribute income, even at the cost of (or because of) war and revolution. In most respects, this future is as desperate as the one Limits prognosticates directly. We can tinker on the margins but are faced with Scylla and Charybdis if we believe Limits' conclusions.

This is a false dilemma. Limits is wrong on its timing if nothing else. Because Limits' time frame is wrong, we can afford to grow; indeed we must. A slow-growth world is considerably more tolerable if incomes are well above current world or even U.S. levels. If per capita income rises at 2% a year, the arithmetic of exponential growth shows a doubling every 36 years. In two centuries incomes could be some 30 times as high as they are now. With the human development that it would enable, this is a future to be welcomed, not deplored, assuming that pollution and population control can be successfully implemented.

To put this issue another way, how does one reduce growth? Limits clearly does not recommend stopping all growth, and suggests that any activity "that does not require a large flow of irreplaceable resources or produce severe environmental degradation might continue to grow indefinitely" in its "equilibrium state" (p. 175). But most such activities suggested by Limits (e.g., research, art and education, but not leisure) are measured by the GNP, and Limits is in fact arguing for a different mix in the GNP. The problem, then, is not how to reduce growth but how to rechannel it.

2. Regulating The Mix Of Goods and Services

Limits does not suggest the means by which we could best rechannel growth, and argues for more data and analysis. It does call, however, for a simultaneous "ongoing program of action" (p. 182), and correctly suggests that taking no action is equivalent to taking strong action.

The Club of Rome sponsors are equally vague as to means, in a Commentary chapter, but emphasize the need for "a fundamental revision of human behavior and.....of the entire fabric of present day society" (p. 190). They call for "an overall strategy," a "joint venture," and achievement of a "harmonious state." The basic argument, and a common one, is that because everything in the world is causally interrelated, we should act on the "whole," which requires at the very least "comprehensive" planning and administration. A recent article in the New York Times Magazine (Bertram Murray, Jr., "What The Ecologists Can Teach The Economists," December 10, 1972) carried this kind of argument to an equally common conclusion--a world economic system "managed by an international team of planners, most reasonably organized by the United Nations" or at the very least a domestic economic system run by government through detailed regulation and/or direct ownership and designed to eliminate the allegedly harmful results of competition and profits.

Such arguments commonly fail to recognize major problems with their recommendations. First, while democracy, liberty and responsiveness may in principle be compatible with state-run economic systems, there are strong theoretical and historical grounds for believing that the greater the involvement of the bureaucrats with the myriad of day-to-day human problems and decisions, the greater the dangers. Second, the record of state-run and/or strongly regulated industries is one of near-universal inefficiency in the large, amply documented in many studies (remember the Penn-Central and Lockheed, to say nothing of experience in Eastern Europe and many LDC's). Such inefficiency means, of course, resource waste and extra pollution. Third, our ability to understand and measure, let alone adequately control, the incredible diversity of economic links is extraordinarily limited. How many ecologists would claim that they could improve on nature in managing the hourly life of each insect on a half-acre plot? A number of socialists, in fact, believe that socialism requires a competitive system of "free" (albeit state-owned) enterprises, prices, and consumer decisions to work well.

Most fundamentally, the calls for grand planning and regulation fail to recognize that economies are miniature ecological systems, with many self-regulating feedbacks. We need not manage every item, as such, to control the overall direction of the system. We can harness natural forces (such as self-interest) to our mutual advantage. For example, simply by reducing taxes we can reduce unemployment, and even though we cannot begin to intervene intelligently in each of the millions of individual buying and hiring decisions which lead to this result, we do not need to.

Our problem, then, becomes one of deciding when and how to intervene selectively to reduce the bad outcomes. It is precisely because pollution costs are not borne by consumers in the normal price system that we must act (what economists term "internalizing the externalities"). But the necessary actions may be as limited as restricting (by quota or taxes) effluents directly, and ignoring the myriad processes of adjustment by which the overall level of pollution is reduced.

For example, some people advocate clamping down on production of resource-using and pollution-producing goods as such. This requires a rationing apparatus in which a bureaucrat decides who gets what, according to rules which can never capture the idosyncracies of individual needs, precisely because they must be reasonably simple and "fair." Queuing features are likel to eat into all that leisure we are supposed to be gaining, and the consumer pays for the overhead costs of the bureaucracy. This also requires tracing ou the materials and energy and pollution involved in each good and service. Thi is not only a near-impossible task, but also one which may present some surprises. If the sum total of materials and energy involved in increasing medical services were traced out, they might well turn out to be greater than those of autos. Mass transportation on any significantly larger scale than at present requires more steel and energy by far than automotive transport per trip (except for big cities' rush-hour commuting, most trips would involve large trains or buses carrying only a few passengers at a high per mile cost), may stimulate far greater city densities, and if accompanied by automobile restrictions, will reduce substantially consumer job and recreational mobility. "Services" such as air transport involve more materials-energy use per dollar than "industrial" outputs such as furniture and clothing.

The crucial point is that government need not involve itself in deciding such complicated investment details, for all goods and services, on the basis of resource and environmental impacts if it limits effluents directly through taxes or regulations. If everybody who uses up clean water must pay, then we can largely ignore precisely what products and services are affected.

This is an oversimplification, of course. Pollution control administration is in general tricky and complicated, and there are numerous special cases.

But even with the FDA, with its limitless and complicated set of responsibilities, exposure to political pressures, and impact on the consumer (when did any of us last eat swordfish?) has discharged its duties tolerably well. We are reasonably well protected from dangerous food and drugs with a reasonable minimum of direct intervention in production and consumption, and at a negligible direct dollar cost. We are not protected against completely unforeseeable catastrophes--but any system carries that risk. We may need special international arrangements for whales and DDT--but the Hudson River scenery is essentially a local problem.

Similar arguments apply to natural resources. If copper becomes more expensive, it will be self-rationing, and the scarcity will stimulate the search for production substitutes, as well as reduce consumer purchase of copper-intensive products. We can foresee a small number of particularly acute potential problems--such as natural gas shortages--and this may argue for targeted intervention to reduce future demand (a tax to raise gas prices, higher home insulation standards, or research into coal gasification). Indeed, careful, early intervention should reduce the need for later measures of desperation, such as deciding which consumer has his home or job cut off.

The heavy hand of government is far more visible in the draft, in local zoning, and a host of other "direct" contacts with the citizen than in the near invisible impact possible with effluent charges and standards. Moreover, the rate-setting functions of the ICC have more impact on geographic location of industry than EPA will probably ever have. Government regulation is imperfect, often disastrous both substantively and equitably, and unfortunately we can expect more rather than less. But the degree of "more" reasonably foreseeable hardly seems likely to <u>require</u> revolutionary changes in the way citizens and public and private organizations carry out their daily business, let alone in fundamental value systems. The most important and pressing issues lie in the degree of clean-up, and in the relatively subtle implementation questions such as effluent charges versus effluent quotas.

Indeed, if the prices of goods and services included the full costs of resource exhaustion and pollution, we would not need to bother with "controlling" growth. If technological progress and population growth stopped, we could reach a natural no-growth equilibrium without further action, just as we could in a world without pollution problems. If technological progress continued, we would be so much the better off. As <u>Limits</u> states, a "stabilized world" without imminent catastrophe is possible.

D. <u>Conclusions</u>

We can conclude, as a first and tentative approximation, that the direct and indirect messages carried by <u>Limits</u> are neither necessary nor sufficient grounds for radical action at this time. The possibility is there, but at the very least the current verdict on <u>Limits</u>' specific conclusions should

be "not proven." Even if the balance of the probabilities were on Limits' side with respect to the imminence of disaster there would still be an overwhelming argument for further delay--we can afford to waste another decade even if we only have another century--simply because the consequences of a mistake would be so grave if Limits were wrong. The infringements on human freedom and material well-being brought by strict no-growth policies enforced by government edict and government bureaucracy would probably be overwhelming, in spite of any attempts at amelioration. And they could well be unnecessary.

Some things--such as controlling population growth and reversing the growth of pollution--should be on any reasonable man's agenda at this time. But attempts at halting or directly rechanneling growth, or immediately "eliminating" pollution, should not be on the agenda, unless a far more compelling case can be made. Prudent men do not govern their lives by attempting to hedge every risk, if for no other reason than that such hedging carries costs and risks of its own. The costs and risks of no-growth policies appear unacceptably large.

Moreover, the problems of effectively reducing pollution within the existing system of human values and institutions are large enough, though not politically or practically impossible, so that utopian calls for revolution may divert our energy from what we can do. The greatest irony of all would be to attempt to solve all our problems simultaneously, and to fail not only in the larger effort but also in the particulars.

(DRAFT, PLEASE DO NOT CITE)

URBAN LAND USE PLANNING FOR INDUSTRIAL DEVELOPMENT

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URBAN LAND USE PLANNING FOR INDUSTRIAL DEVELOP

The purpose of this paper is to provide those in the industrial development field with a glimpse of the local governmental land use planner's perspective on planning for industrial government. I am not trying to present this view as good or bad, right or wrong; only to present it the way it is. The purpose is to increase your understanding of land use planning and its role in industrial development and by virtue of your response, the understanding of this land use planner. My hope is that our discussion may lead in the direction of mutual professional growth.

A few points of clarification: the views presented are meant to represent those of the land use planning profession working at the local level of government or possibly at the metropolitan level; not those of the economic development planner, regional planner, social policy planner concerned with providing compensatory social services, nor those of the private consultant on industrial development strategy or site development. For purposes of this discussion, industrial development includes manufacturing and wholesaling activity but not the extraction of raw materials or the retail distribution of goods and services.

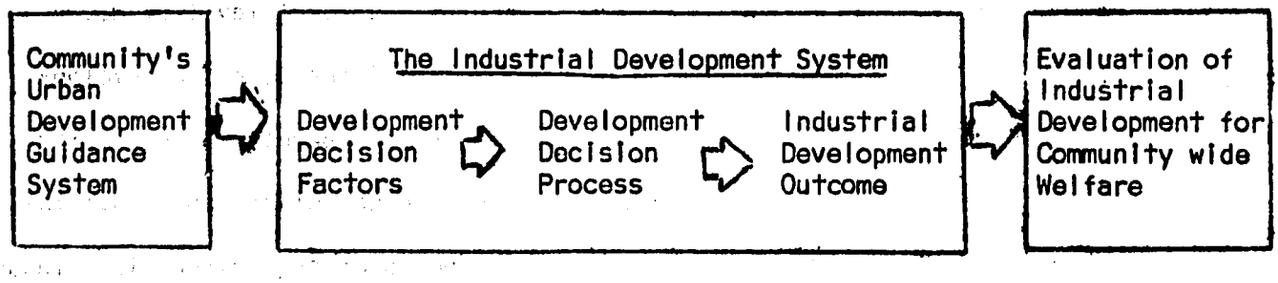
I. The Urban Land Use Planner's Conceptual Model of Industrial Development

This urban land use planner conceives of the industrial development planning problem as consisting of three related parts: the industrial development decision system, the community's urban development guidance system by which the planner hopes the community may influence the course of industrial

development toward community welfare objectives, and thirdly the means by which industrial development outcome may be evaluated for its impact on community welfare. The industrial development system itself consists of three parts: the decision process, factors which influence that process, and the outcome of the decision process. Figure I diagrams the way in which these components of the industrial development model relate to each other in the perspective of the land use planner.

Figure I

The Planner's Conceptual Model of Industrial Development



It is the middle part of this conceptual model with which the industrial development organization will be most concerned. That is where such a professional is devoting most of his time and effort. Thus that is where we will begin, with a discussion of decision factors and decision outcomes.

There are three types of decision factors which are of interest to the land use planner and hopefully to the industrial development profession: contextual factors, property characteristics, and decision agent characteristics. Each type influences the decision processes in an unique manner, and each is related to the guidance system in an unique manner.

Contextual factors include considerations that limit and determine the overall rate and type of change in the community, determine its relative attraction to industrial development compared to other communities, determine the relative impact of property characteristics on the development decisions, and determine the impact such development will have on community goals and problems. Contextual factors include such items as tax rates, water and sewer capacities, power supply, avaiability of raw materials, economic structure, overall characteristics of the industrial land supply, labor market, access to regional markets, labor union attitudes, quality of schools and general community livability.

Property characteristics are of three types. Physical characteristics, such as topography and soil conditions, are inherent to the land and cannot be changed except by direct modification of the site itself, e.g., by grading. They must generally be accepted as constraints and cannot be much influenced by the community's policies and the action instruments of its guidance system. Locational characteristics, on the other hand, are not inherent in the land but are derived solely from the relative location of the site with respect to the spatial pattern of prospective employees and markets, transportation networks, and surrounding properties. Neighborhood quality and accessibility to the regional transportation system are examples of locational characteristics. Changes in locational characteristics thus depend on developments occurring off-site since the site itself is fixed in space. Perhaps then we might consider locational characteristics more subject to influence by the guidance system. The third category, institutional characteristics of the site,

represents attributes that are applied directly to the site, but which are not inherent in the site. Imposed by social institutions including government, they include such things as the site's zoning, parcel sizes, site cost, its inclusion or exclusion from various service districts such as water, sewer, fire protection, police protection, trash collection, and from taxing districts institutional characteristics are obviously subject to change by local government's guidance system.

Decision agent characteristics, including those of the predevelopment landowner, the development agency, industry type, and type of firm, are the third important set of factors influencing the location of industries. Decisi agent characteristics are not generally influenced directly by public policy in the way that contextual factors, locational and institutional property characteristics are, short of the municipality itself forming an industrial development agency and becoming a direct participant in the industrial develop ment process.

As outputs of the industrial development decision process we might list such outcomes as type of industry (heavy or light, history of labor problems), level of activity (number of employees, output capacity), location, site and plant design, wage levels, assessed value of plant and equipment, and its demand for public services including solid and liquid waste collection and treatment, fire protection, power, water and so on.

While the industrial developer focuses directly on the decision process in the middle of our conceptual model, playing an activist role in trying to influence the participants of the decision process, the urban land use planner extends the model to include the guidance system factors and the evaluation factors. He then concentrates on these two extensions of the model rather than becoming actively involved in the development decision. His interest in the guidance system derives from the purpose of planning which is to guide development so that the interests of the general public are served. The planner's concern for extending the model in the other direction, to include evaluation, is based on his need to seek the answer to the question, "so what?", "What is the impact of a potential industrial development for community welfare?"

The community's urbanization guidance system has two parts, decision guides and action instruments. The decision guides are the plans and policies of the public decision makers (e.g., the county commissioners or city council). The land use plan, which will be discussed in detail below, is one of these. Decision guides do not intervene directly in the industrial development process by changing the input factors but rather indirectly through their influence on the action instruments of local government and more subtly through their persuasive power on private decision makers.

The direct action instruments, on the other hand, intervene directly in the industrial development process. They consist of regulations (zoning, subdivision regulations, health and sanitation codes, emission standards, and so on), public investments (highways, water and sewer systems, land acquisitions

for industrial parks), incentive/disincentive programs (e.g., taxation practices and allowances, and charges for development services such as water and sewer), and finally the informal role of the planner in providing information, advice, and persuasion directly to the development decision process when the opportunity arises. It is through this guidance system that the land use planning process hopes to influence industrial development to achieve community welfare.

To the planner industrial development is not an end in itself. In addition to influencing the industrial development system through the guidance system the planner is interested in evaluating the impact of industrial development on community welfare. Thus, the evaluation of the industrial development is included as the third part of the model. Here the planner is concerned with evaluating the impact of the industrial development on the local government's fiscal picture (i.e., its implications for revenues and costs to local government), impact on the local environment (e.g., displacement of ecosystems and the residuals problems of solid wastes, liquid wastes, air pollutants, noise, glare), impact on the local economy (e.g., economic stability, per capita income, growth potential, spin-off economic growth, unemployment), and the further stimulus to urbanization provided by increasing the number of jobs in the local scene (e.g., residential development, commercial development, highways).

Figure 2 summarizes the concepts discussed to this point in the paper. The remainder of the paper will discuss three parts of this conceptual model: the land use plan as an example of a decision guide, the action instruments component of the guidance system, and cost/revenue analysis as an example of evaluation.

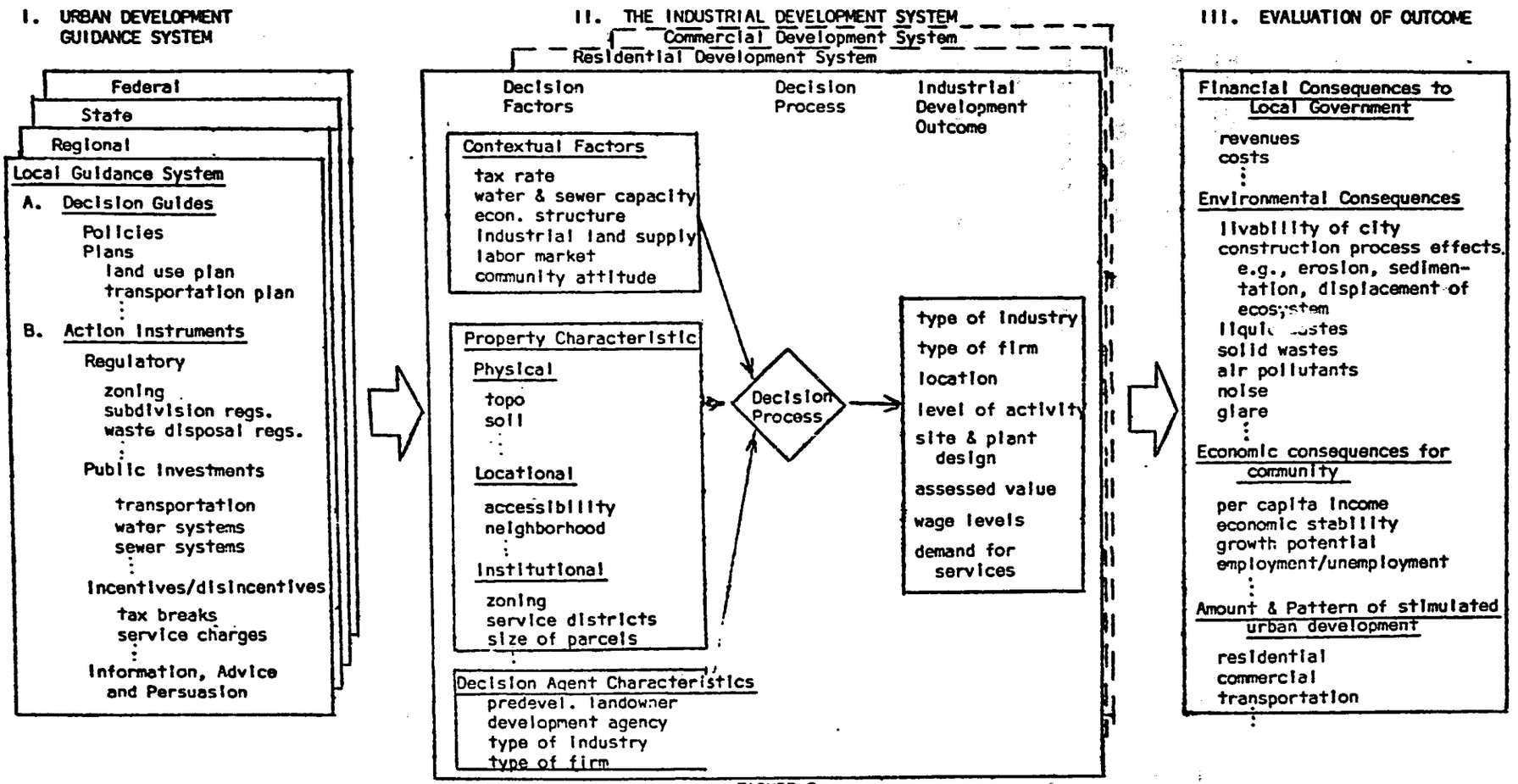


FIGURE 2

THE URBAN LAND USE PLANNER'S CONCEPTUAL MODEL OF INDUSTRIAL DEVELOPMENT

II. Designing the Long Range Land Use Plan as a Policy Instrument

Stuart Parry Walsh, President of Development Planning Associates, has stated that a frequent initial mistake in industrial land development is neglecting to inquire closely about future development of surrounding land. "The adjoining farms may be about to produce heavy crops of subdivisions whose residents will probably protest the nearby presence of an industrial tract... Or the city may have one of the adjacent farms in view for a new sewage treatment plant. Or a new airport may be planned for a location that will be considerably more distant from the property than the present one." (Walsh, 1963, p. 1)

Attention to a long range comprehensive land use plan and the planning process behind it by the community's legislative body, the industrial development organizations and prospective firms can help avoid this mistake on the part of both public and private decision makers.

The land use plan is a design for the future physical form of the city. The plan usually features a large-scale, map-like drawing of the long range, physical design of the whole community, calibrated to a fixed point in future time (usually some 20 to 25 years hence) or to a fixed population level. This physical design is expressed in general, not detailed terms, and covers the spatial distribution and densities of land use activities including industrial uses, public and private facilities, circulation and utilities, and sometimes a civic design proposal.

Land use plan making is perhaps the most traditional and may still be the most common context from which an urban planner views his role in industrial developments.

The land use plan making process consists of three phases: "tooling up" studies, estimating future location and space requirements, and formulating the land use design plan.

Tooling up studies: In preparing for land use plan making, the planner traditionally conducts a series of studies under the general heading of "tooling up" for land use planning. Involved here are studies of the urban economy, analyses and projections of employment and population, survey of resident attitudes and behavior, studies of the natural physical setting and natural processes occurring in the urban region, studies of the existing man-made urban physical plant (houses, utilities, etc.), and vacant land studies.

Of first importance are the studies of the structure and vitality of the urban economy as a key consideration in gauging the amount and the rate of land development that is likely to occur in a city. Accordingly, considerable attention is given to methods of studying the makeup and general health of the urban economy. Projection of employment and population prospects for the future are then made as extensions of these foundation studies. The employment projections supply the actual yardsticks needed for estimating amounts and rates of future land development.

These basic studies demonstrate the planner's recognition that the growth destiny of an urban center is largely determined by its productive activity. Production and distribution activities in the city or metropolitan area create jobs, and employment opportunities attract people. Most fundamentally, then the land use planner assumes that the urban economy, especially the economic base industries, conditions the amount of future land development

that needs to be accommodated. Thus studies of basic employment are a key element in population forecasts, and population estimates are then used in scaling land requirements for urban residential and the service employment activities required by those residents. More directly, for industrial development, estimates of future land requirements for industrial uses are based on manufacturing employment prospects.

It is important to note the planner's attitude toward economic development in this process. It is largely passive; he is making projections as a step toward land use planning; he is not planning the amount and type of economic development.

With the growing concern for environmental quality now sweeping the nation, however, attempts to structure local industrial activity take on a new light. Many planners can now be found among the burgeoning group who question the whole "growth" consciousness we have taken for granted in the past. Perhaps this change in consciousness of some planners and citizens is somehow psychologically associated with the concern for population explosions and environmental deterioration. At any rate, we can expect planners increasingly to question industrial development instead of merely accepting it as desirable, asking how much, finding the space for it, and tracing out the land use implications on a map as he has done in the past.

Examples abound. Oregon, as you know, now has a state policy to discourage inmigration. "Please come visit; but don't stay." The governor of Delaware has initiated action a year ago to abate the location of proposed industries along the sensitive ecological areas of Delaware's Atlantic coastline. The

law will reportedly block the realization of several thousand jobs and $750 million in planned developments including a large oil refinery (Wall Street Journal, November 4, 1971). Closer to home, Chapel Hill turned a cold shoulder for environmental reasons to the overtures of Fiber Industries to locate on a nearby Orange County site. Last fall, the prospective location of Whittaker Industries in Northern Orange County caused such questioning about potential environmental pollution, lack of adequate water volume in the source stream and sewage treatment capacity, and the high cost of supplying public utilities to the site, that the community withdrew its support. Finally, the American Society of Planning Officials is currently preparing a Planning Advisory Service report which promises to delve into "nongrowth" planning strategies. (ASPO Newsletter, November, 1971)

In addition to those studies concerned with estimating the demand for land space, the tooling up studies also include a series of Studies concerned with the land and facility supply side of the picture. These include a study of the existing land use pattern, a survey of the condition of present public and private property improvements, and their capacities including industrial plants; and a survey of vacant available land. These studies describe the characteristics of the land supply for urban development, including industrial development.

Estimation of future requirements for base economic activity

After the economic analysis and other "tooling up" studies, the second step in the traditional land use plan making approach is the derivation of locational principles and standards and the derivation of space using requirements.

Locational requirements. These begin with statements of general principles on the location of employment. For example those suggested by Chapin (1965, pp. 372-373) are:

Manufacturing Areas

1. Reasonably level land, preferably with not more than 5 per cent slope, capable of being graded without undue expense.
2. Range of choice in close-in, fringe, and dispersed locations.
   Extensive manufacturing: large open sites for modern one-story buildings and accessory storage, loading and parking areas in fringe and dispersed locations, usually 5 acres as a minimum, with some sites 10, 25, 50, or 100 or more acres depending on size of urban areas and economic outlook for industrial development of extensive lines of activity.
   Intensive manufacturing: variety of site sizes for modern one-story or multiple-story buildings and accessory storage, loading, and parking areas in close-in and fringe locations, usually under 5 acres.
3. Direct access to commercial transportation facilities; in fringe and dispersed locations, access to railroad, major trucking routes, cargo airports, and, in some urban areas, deep water channels; and in close-in locations, for a major proportion of sites, access to both railroad and trucking routes, with the balance adjoining trucking thoroughfares or, if appropriate, port areas.
4. Within easy commuting time of residential areas of labor force and accessible to transit and major thoroughfare routes directly connected with housing areas.
5. Availability of utilities at or near the site such as power, water, and waste disposal facilities.
6. Compatibility with surrounding uses, considering prevailing winds, possibilities of protective belts of open space, development of "industrial parks," and other factors of amenity both within the manufacturing area and in relation to adjoining land uses.

Wholesale and Related Use Areas

1. Reasonably level land, preferably with not more than 5 per cent slope, capable of being graded without undue expense.
2. Range of choice in close-in and fringe locations, site sizes usually under 5 acres.
3. Direct access to trucking routes and major street system for incoming goods and outgoing deliveries; frontage on a commercial street or in well-served wholesale centers essential; railroad access for minor proportion of sites or centers.
4. Suitability for development of integrated centers, with consideration for amenity within the development and adjoining areas.

Another example of statements of locational principles or criteria is provided by a report on Industrial Land Development for the Baltimore Regional Planning Council by Dorothy Muncy. It was done in 1959, but is still representative. (Muncy, 1959, pp. 55-57)

Criteria for Future Industrial Land

Objective: A planned distribution of industrial activity throughout the Region, among most of the planning areas within each County and the City, to avoid the inefficiencies of industrial congestion.

1. Land must be physically suitable for industry.

First quality industrial sites are level, well drained and accessible. Cast-off land, not considered useful for any other purpose, will not qualify as satisfactory (or marketable) plant sites. Therefore, swampy, hilly, remote or inaccessible land does not constitute a useable industrial land reserve.

The gradient usually should not be over 5%. Occasionally sites with steeper grades, if well located with respect to freeways or railroads and to centers of population, can be economically graded for industrial use.

Exceptions:

a. Land near deep draft channels is becoming so scarce that drainage and load bearing problems will not be considered a serious deficiency.

b. Laboratories and headquarters office buildings are now beginning to seek large suburban sites partly level but with some sections having rolling terrain, trees, streams and other interesting natural features.

2. Utilities and services should be available or feasible.

Large industrial establishments often drill wells for their water supply, construct their own water and sewage treatment facilities, and are such large consumers of power that utility lines can be extended profitably to remote sites. Small industrial plants, however, are not self-sufficient, and must rely upon the community for services. In planning for extension of future water mains and sewer trunk lines, therefore, the availability and suitability of adjacent land for industrial use must be considered.

3. Railroad sites continue to be vital to many industries.

Prime railroad-served sites are land fronted by a major highway and backed by the railroad. When the highway and railroad are immediately adjacent, requiring a grade crossing to reach the plant site, such a location is not prime industrial land.

Sites to be zoned for industry along the railroad should be not less than 1,000 feet in depth, preferably 2,000 feet or more. Shallow tracts under 500 feet in depth restrict expansion and cannot be used efficiently by most types of industries requiring rail service only exceptions are central city sites.

4. Prominent sites on freeways are an important new location trend for industry.

Many light industries and laboratories do not require rail service at the plant site allowing greater flexibility in their site selection. The standard for plant location with respect to distance from a highway formerly was within one mile from a major road. Now the trend is to locate immediately adjacent to a limited access highway. Industries seek the advertising advantage of a prominent site for their attractive new plants, as well as the economy of an uncongested route for employees driving to and from work and the availability of the freeway for truck service.

Industry should not have to locate in back of a residential area. Back of residential locations, or sites which require industrial traffic to move through narrow residential streets to reach the major highway are indicative of poor community planning. Such sites cannot compete market-wise with attractive prominent locations.

Front land along freeways and, particularly, sites at existing and possible interchange points are prime. However, all four corners of the interchange should not be zoned for major traffic generators. Freeway capacity can best be preserved by distribution rather than concentration of industry.

Highway sites can vary in depth from a minimum of approximately 600 to 800 feet up to 2,000 feet or more. It must be remembered that for sites fronting on freeways, space for frontage or service raods must be provided.

The great need in every growing metropolitan area is circumferential freeways, with the existing radial highway pattern focused upon the urban center, industries locating in the suburbs need adequate linkage between the dispersed communities. Such circumferential roads provide excellent sites for industry, with or without rail.

5. Land adjacent to or near airports should be reserved for special airport-oriented industries.

Industries which require flight test facilities, or are dependent upon air freight for a substantial portion of their receipts and shipments should have the opportunity to locate near an airport. Also, some industrial firms now seek the time-saving advantage of proximity to an airport terminal because of the extensive air travel required in a headquarters office, operating a laboratory (for example the Research Triangle Park), or a national service center.

6. Land near existing or potential deep-draft channels should be reserved for tanker transport industries.

This report has strongly recommended that large tracts of waterfront land be immediately rezoned for industrial use, and that these prime sites, because of their scarcity along the Eastern Seaboard, be reserved exclusively for water-transport oriented industries.

7. Environs of industrial sites must be attractive, not blighted.

Responsible industries, like most individual families planning to build a new home, want to locate in an area that is and will remain attractive. Modern management is spending millions on modern architecture and landscaping for new plants. Industry does not want to build next to blighted areas, whether residential or industrial.

8. Size of industry tracts should vary.

In the past, many communities have followed the practice of concentrating all industrially zoned land into two or three large districts, under the assumption that this segregation of industry best protected the community. Such concentrations of employment, however, can generate a traffic density which will paralyze vehicular movement on adjacent highways during the morning and evening changes of shift.

Many industries today, however, seek large open sites where they usually build upon less than 20% of the land, and where they will not be crowded by more densely developed industrial neighbors. A major reason for industry's movement out of the central city is to avoid traffic congestion.

Therefore, the Region in selecting land for an industrial reserve should provide for three types of industrial sites:

a. Individual plant sites, ranging from 25 to 10 acres or more.

b. Planned industrial district sites, minimum size of approximately 10 acres.

c. Special sites for industries requiring large land areas, ranging from 200 to 1,000 or more acres.

A planned "scattering" of laboratories, headquarters offices and factories on industrial sites has both physical and aesthetic advantages. A more "open spaced" development of the region can be obtained. An individual plant or laboratory, with a low structural density (i.e. land coverage) can provide "a green oasis" among commercial and residential developments.

Too large a concentration of industrial plants must be prevented through planning and zoning. The major exception is waterfront land now served by a navigable channel or with the potential of deep draft navigation. The scarcity of such land, together with the low employment and structural density characteristics of the industries which require such locations, warrant industrial zoning of all such waterfront land.

9. "Nuisance" industries need efficient locations.

Every metropolitan region requires industries often regarded as "nuisances." Junkyards, open storage of construction materials, and fuel storage areas are usually objected to first, as a hazard to health or property, and second, because of their appearance.

Baltimore as a great steel-producing Region is dependent upon a large local supply of scrap. Coal, oil and gas will continue to be major sources to energy for the industries and homes. Even with new inflatable storage domes to provide cover, construction materials will require large land areas. Therefore, efficient sites must be provided for these industries.

While such uses are not entitled to "front" sites along the freeways, proximity to major highways is prerequisite. The truck traffic generated by these activities should not travel through residential areas to reach the storage facilities. However, additional zoning controls will be required to protect adjacent land uses.

The Need for Long Range Reserve

Industrial land must be reserved well in advance of the Region's need. Good land should be set aside now to meet the anticipated industrial growth in the next 10, 15 or 20 years, and even beyond. This concept of reserving land for future economic activity is not easily understood or readily accepted.

Chapin and Muncy are illustrative of the kinds of factors which would be covered in a statement of guiding principles for the location of industrial activities.

Sometimes the principles are refined into a set of more specific yardsticks called location standards. They supply more specific measurements for location principles. Thus, "easy commuting time" may be converted to a convenience standard of "20 to 30 minute maximum commuting time." Sometimes the locational principle can be converted to a performance standard, particularly for industrial uses. Deriving from health, safety and amenity aspects of the public interest and neighboring private property interests, (as opposed to convenience aspects discussed above), performance standards might provide criteria for evaluating the hazards or nuisances such as smoke, dust, noise, glare, odor, wastes, or traffic often created by industrial uses. ASPO's Dennis O'Harrow, in 1951, began urging performance standards as the primary basis for the location of industrial activity. (O'Harrow, 1951; Chapin, 1965, p. 378) Although largely associated with industrial zoning ordinances, performance standards can also be used as criteria for delinating industrial land use zones in the land use plan making process instead of the more traditional approach under which industries were grouped into light, medium, heavy, and unrestricted categories regardless of their actual operation of a particular firm.

Trial Application of principles and standards. The location principles and standards, together with major assumptions and results of the "tooling up" studies may be used to outline tentative locations of industry (and other uses)

in schematic form. By schematic, we mean that location principles are applied to the specific urban site in map form to suggest a desirable land use pattern without regard yet to the amount of space needed.

Space requirements. The question here is: how much space should be reserved for industrial uses? residential uses? commercial uses? public facilities? This step is one of scaling the land area required to accommodate industrial growth as well as the concommitant residential and commercial growth over the next 20 to 30 years. We can break down the process of estimating space requirements for industrial land uses into three steps:

1. Analyze the characteristics of existing manufacturing and wholesale uses in the planning area with particular attention to densities, conditions of plants, excess site capacities, and trends in space usage.
2. Develop local standards for future densities in number of employees per acres for each category of manufacturing and wholesale activity based on anticipated growth in each category, expected and desired changes in intensity of use due to modern industrial technology, goals and objectives, and location in the metropolitan pattern (inner city vs. suburban location). For example, Muncy's industrial land development report for the Baltimore region predicted the density of industrial workers will be reduced from a regional average of 32 employees per acre to 12 employees per acre in 1980. (Muncy, 1959)
3. Apply the density standards for each category of manufacturing and wholesale employment to obtain an estimate of future land requirements in acres by category of industrial activity.

A more detailed explanation of these steps may be obtained in Chapin's Urban Land Use Planning text, pages 386-400. (Chapin, 1965)

The land use design. The final step in the land use plan making process is the creative integration of the information and understanding generated in the previous steps. This procedure includes determining how the supply of vacant and renewal land, as described by the tooling up studies, matches up to the locational and space need requirements. Trial distributions of projected industrial land demands are made onto this land supply by referring to the location principles and standards, the schematic land use design, and the estimated space needs.

The result of this process is a land use plan, which includes industrial uses as an integral part of a proposed design for the future urban activity pattern of the community. It is based on projected growth, the existing pattern of urban uses and community infrastructure (utilities, transportation, schools, parks and so on), the physical characteristics of the urban region, and certain locational principles which are based on both the need for land uses to relate well to each other and the need for urban activity and urban development to relate to the natural processes of the land-water-air environments.

In addition to the general land use plan, special industrial development plans are sometimes made by planning agencies as part of the comprehensive planning program. (For example, see Baltimore Regional Planning Council, 1959; Center for Urban Studies, University of Chicago, 1966; San Diego City Planning Department, 1970; New York State Division of Housing and Community Renewal, 1963.) In their general approach, none differ greatly from the rationale

described above. All of them however devote more specific attention to particular local problems, to recommendations for their solution, and to the implementation of solutions.

Perhaps one of the more commonly used plans for reference purposes, is Dorothy Muncy's, Industrial Land Development, Technical Report No. 2; Baltimore Regional Planning Council, Maryland State Planning Commission, done in 1959, 13 years ago. The purposes of this industrial aind study were:

> " (a) to determine the land area requirements of industries which have long been basic to the Region's economy, and of new industries growing from an expanding technology, which could advantageously locate in the Baltimore Region; (b) to recognize the diversity of location requirements of industries that are now or will be in the Baltimore region, particularly noting new trends in undustrial management's location criteria; and (c) to identify future locations for industry in the Baltimore Region that would be best served by the highways, deep water channels, and utility extensions to be built within the next twenty years. ... The Baltimore Regional Planning Council decided to look at the total land of its Region and to identify general areas (but not specific sites) which could provid the most attractive and efficient sites for the factories, laboratories, warehouses, and terminals to be built in the next twenty to twenty-five years." (Muncy, 1959, p. 8) (emphasis added)

The report contains four elements: (1) an analysis of industrial employment and a projection for 1980; (2) an inventory of industrial land use and industrial zoning; (3) an estimate of industrial land requirements for 1980; and

(4) a map recommending for local consideration major areas with potential for industrial development.

The similarity is obvious between this special report on industrial land and the general approach outlined above.

The land use plan and the process of planning inquiry which lies behind it provides some useful assistance in industrial development. It provides:

> "an overall general policy statement about the pattern of future development for the community. Such a plan is a useful step toward identifying the land needs and a potentially appropriate land supply. Nature alone cannot create good industrial sites. And industry has special land and location requirements that cannot be met most efficiently from land left over after residential, commercial and public uses have been designated. Advanced planning for industry, in the context of the full network of urban functions, is necessary. Zoning, advanced land acquisition, the location of airports, highways, water and sewer trunklines and treatment facilities, flood control projects all enhance or even largely create prime sites for industry (when planned and coordinated). Conversely, planning without an awareness of industry's needs, or the implementation of local governmental regulations and public investments without either planning or an awareness of industry's needs, can destroy potentially excellent sites from what is almost always a limited supply." (Muncy, 1959)

Secondly, the process of developing a land use plan provides a rich store of information and analyses for both public and private decision makers, including industrial developers: the base maps and tables from surveys of existing urban uses, densities, vacant land characteristics, natural characteristics, utilities and other services, and economic and population analyses and projections.

The comprehensive planning context for industrial development also has decided limitations, however. The comprehensive plan itself emphatically focuses on ends, not means. It describes where to be, but not how to get there.

The comprehensive plan therefore, does not ordinarily include schedules, priorities, cost estimates, zoning ordinance, capital improvement program, or detailed project or small area development plans.

The plan is long range, usually looking ahead at least twenty years, and focusing attention on the end point of that scale. Little attention is given to the intervening time period or for ongoing development after that time.

In maintaining a high level of generality, the plan stresses the general location, character, and extent of major physical components of the future city.

In short, the plan is a generalized but scaled presentation of future development at a point in time. It is not a detailed blueprint, but remains always a general, schematic guide; a policy statement.

An important implicit assumption exists in this traditional view. The planner is assuming that the existing and future economy, with its implied employment and population consequences, are givens. They are assumed as projections or, if controlled, at all, controlled only by higher order policy. The scope of land use planning is to design a land use pattern to accommodate the projected economic activity and the residential and retail activity it generates in the surrounding urban region. This land use design becomes the principal component of the so-called comprehensive plan.

All in all, this comprehensive land use planning approach may be labelled a passive involvement of the land use planner in industrial development. He is primarily concerned with (1) deriving the space requirements and most appropriate location requirements for an already given level and structure of economic production activity and then (2) specifying the spatial solution to

those requirements. It does not include actively influencing the level and structure of economic activity. Implementation instruments are viewed as means to accommodate industrial development with as little adverse impact on the residential areas as possible, and to design transportation and utility systems to accommodate the urban activity levels at least cost to local government.

Furthermore, while comprehensive planning may plan for industrial growth and may allocate sufficient and appropriately located space for industry, it does so only on paper, not in the real world. At best, comprehensive planning is a useful but very indirect influence in the real world evolution of the community. We therefore need to look to the potentially more active roles of the land use planner in local government's attempts to (a) influence the level and type of industrial development, (b) influence its location within the community, and (c) control its consequences on the immediately adjacent properties and largercommunity environment and on the municipal government. The urban land use planner plays more active roles in two ways: (1) as adviser and participant in the formulation of the more action oriented instruments of the local industrial development guidance system and (2) as analyst/evaluator of the impact of public investment and industrial development alternatives.

III. The Action Instruments of the Guidance System as a Means to Reserve and Control Land for Industry

Regulatory Instruments

Zoning. At first glance, zoning would appear to be an ideal means to reserve adequate space for industry, in suitable locations, as the real world

counterpart to the spatial allocation made on paper by the land use plan. But, historically industrial zoning has its roots in the concepts of health and safety and nuisance controls and not in concept of reserving suitable land for industrial development. Furthermore, urban planners' own natural biases place emphasis on the city as a place to live and not as a production center. In addition, the political game of zoning further aggrevates the problem.

The practice of limiting industrial uses to special districts in this country began in colonial times when munitions manufacturing and storage facilities were prohibited from the residential areas of town--thus establishing the principle of segregation of dangerous uses from residential areas. The principle was extended, under nuisance law, to include those uses not only dangerous but regarded as a nuisance to people at home. In 1916, New York adopted the first comprehensive zoning ordinance which introduced the need to consider relations between zoning districts as a factor. More recent zoning techniques are departing from the old so-called Euclidean concept by permitting more flexibility in administering zoning.

Nevertheless, zoning began as a means to protect residential property and on balance even today is still largely practiced in built-up areas as a means of providing protection to residential environments and property values. Since most existing zoning ordinances were written in the 20's and 30's, in most cases even before planning began in those cities, zoning is not even necessarily related to planning. As a result, the zoning recipe is in large measure a mapping and reinforcement of the status quo, with considerable greed and politics added but only a pinch or less of planning. The result of this

zoning tradition is that most current zoning practices are based on antiquated concepts dating back to colonial times and conflict directly with the objectives of both comprehensive planning and industrial development planning.

Of all the zoning practices adversely affecting industrial development two still prevalent practices stand out. One is the practice of making zoning districts progressively inclusive (with industrial districts being almost all inclusive and in the least preferred position in the hierarchy of zones). The other is the practice of selecting suitable industries for a zone by means of a "prohibited" list.

The practice of progressively inclusive districts is illustrated by the typical ordinance which provides lower density single family dwellings preferred protection by excluding all other uses. Each succeeding district in the hierarchy of districts then allows most if not all land uses of the preceding district. Under this system, all but a few property uses permitted under the zoning ordinances are allowed in the final districts -- the industrial districts. Thus, single family residential districts are given maximum protection; industrial districts receive the least protection.

Since World War II, many ordinances have been revised to at least exclude residences, except mobile homes, from industrial districts. But the fundamental principle of cumulative permissible uses as one proceeds down the hierarchy of zoning districts still holds and therefore its consequences are still felt in many communities across North Carolina and the nation.

Progressive districting causes several problems. (Shenkel, 1964, p. 250) First, zoning limits the supply of industrial land, thereby increasing its

price. The market competition for industrial space is increased by zoning because nonindustrial demands compete for industrial space while at the same time industry is limited to industrially zoned space alone. Thus zoning limits the supply of land for industry and the absorbtion of industrial sites by non-industrial users contributes further to the artificial limitation on the industrial land supply. This situation encourages a rise in industrial land prices, to a point where these prices can become a detriment to industrial development by rising above the threshold levels of some firms and discouraging others.

Secondly, the same zoning practice which creates the artificial scarcity of land provides little compensating protection for industry. The industrial district comes close to being an area with no zoning restrictions. A mix of transitional uses, so-called cast-off uses such as trailer parks and junk yards, poor site planning, and traffic congestion often characterize industrial zones. The catch-all nature of industrial zones often encourages the poorest land being zoned industrial in the first place.

The result of such zoning practice is a limited supply of low quality industrial land. The encroachment by other uses, often upon the best sites in the industrially zoned district, seriously impairs the efficiency of the land use and circulation pattern within the district and spoils the appearance. Where the supply of suitable land for industry is critical, community planning principles would indicate that maximum productive efficiency for the local region would be gained by providing industry with suitable land adequately protected.

The second problematic practice is one of listing prohibited industries.

it is objectionable because it's obsolete (often copied from other ordinances written in 20's or 30's when a less sophisticated industrial technology prevailed) and because many feel that prohibition should be based not on industry type but on the operating characteristics of the particular plant not of the industry as a whole.

Solutions suggested to the two practices include subclassification of industries wherein industries are classified on the basis of intensity of use; on central city vs. suburban locational propensity; or on the basis of performance standards for noise, odor, glare, vibration and appearance. Solutions also include the use of industrial park districts with landscaping and architectural controls and structural coverage ratios which serve to enhance the utility of the industrial space to the surrounding industrial as well as non-industrial districts while meeting the need for quality industrial space.

The thrust of suggested solutions for the problem of zoning boils down to the need for industrial zoning with a sufficient range of districts all of which are based on industry needs as well as the needs of surrounding properties. Some firms require a zoning district that permits more latitude in respect to allowable uses, performance standards, or yard regulations. Other firms prefer a stringent industrial zoning district to protect their investment from encroachment by residential, commercial and incompatible industrial land uses. However, one also needs to avoid overly restricting industrial districts, since this has apparently also been a problem in some areas (San Diego, 1970, p. 110). An overly restrictive zone, say a scientific research zone, may work a financial hardship on the owner of the vacant land in that category because

of the difficulty of finding likely purchasers or lessees.

Some urban planners are still likely to require some education on the purposes of zoning for industrial needs, but at the same time they are not likely to forget their more traditional concerns of controlling consequences of industrial activity on surrounding properties, on the environment, and on the city's fiscal position. His view is likely to be that both industry and the community need assurance that future industrial plants will be compatible with the other land uses in the vicinity. The best protection can be achieved through industrial zoning codes which set space standards, such as off-street loading and parking requirements, yards, and per cent of site covered by structures -- as well as performance standards on noise, smoke, odor, water and air pollution, radiation, and electromagnetic interference -- to ensure both environmental health and the general livability of the community.

Even with a properly written and administered zoning ordinance, however, zoning is not a totally satisfactory way to preserve land for industrial development. Although it obviously goes a step further than preserving land on a piece of paper or in a policy statement (perhaps an unfair characterization of the comprehensive land use plan), it is vulnerable to political pressur over the longer run. But, as a means to protect land over the short range and as a means to protect industrial developments once started, zoning is more successful.

Nor does zoning seem to be a critical factor in the locational criteria of industries. In her study of plant location factors in North Carolina, in the early 1960's Ruth Mace noted that only 16.5% of the firms studied viewed

planning and zoning protection as an essential service, while 43% viewed these measures as unimportant (Mace, 1963). Faced with the prospect of jobs for residents and the need to expand the local property tax base, local communities are often quick to grant rezonings. Whether such rezoning undermines the community's overall welfare or represents a safety valve permitting escape from an inappropriate ordinance varies from situation to situation.

Public Investment:

Land Acquisition and Development. Direct land acquisition for industrial development is normally done in the private sphere by those having a service to sell to industry, such as a railroad or utility, or by private organizations with capital seeking an investment opportunity from the sale or development of land (e.g., banks, realtors, pension funds, and insurance companies). However, sometimes a non-profit authority, such as a port authority, an urban redevelopment authority, an industrial development authority, or a Research Triangle goes directly into industrial development. More directly, not a few communities have purchased and developed land including buildings for industrial development. This places industrial development in a rare class of land use that has been accorded such treatment in the U.S. along with public housing, urban renewal, and more recently, new towns.

The public purchase and lease or sale of developed parcels does provide more direct and complete control of the type of industry within a community and provides for efficiency in the development of utilities infrastructure. It can minimize potential land use conflicts if the industrial park is properly located. It can also provide better assurance that the land will be held for

industrial use and not sold off for housing or shopping center development. The acquisition of an industrial occupant that will contribute to broader public interests than the provision of jobs alone is also more likely.

Within central cities, urban industrial renewal adds the power of eminant domain in assembling parcels and the public borrowing power to make the necessary infrastructure investments. The sites are then sold or leased to firms, often at less than development costs. Through deed restrictions the community can achieve a high level of control over the types of industry moving into the community. Renewal can be an effective alternative in central cities because of the high cost of land, the problems of private assembly of land, because of the possible long holding periods involved in industrial development or redevelopment; and because of the difficulty in rearranging for transportation and other utilities makes it so difficult to meet the needs of industry through the private market. Already important in older, larger cities of the Northeast, I suspect the importance of this facet of industrial development will one day be upon us in North Carolina and the Southeast. (Muncy, 1959, p. 5, 13-17; Utica, 1963)

The disadvantage of outright public purchase and development of land for industry is that it will not do the whole job. It is unlikely that sufficient land can be reserved through purchase because of the shortage of venture capital and public funds and the alternative opportunities for the use of such funds.

Public Facilities. As early as the preliminary analysis for industrial location, the quantity, quality and cost of public utilities and services is

checked out by a company. The company or industrial development agency asks whether water, sanitary sewer, storm sewer, electric power, gas, fire protection, police protection, mail delivery, telephone service, truck and rail service are adequate or whether they can be made adequate. The meaning of adequate will vary with industry and even with firms and will be geared to the specific cases. Provision of utilities is perhaps the strongest guidance instrument for local government provided it has the will to use it.

Other papers will cover utilities and about railroad transportation. However, it may be appropriate for a land use planner to say something about the importance of public transportation investment since land use and transportation planning are regarded by many planners to go hand in hand. These comments will be limited to highways.

Dorothy Muncy and others have noted the shift from rail to truck for incoming raw materials as well as outgoing product shipments. (Muncy, 1970, p. 4; U. S. Department of Commerce, 1967, pp. 18-19) Furthermore, it is common knowledge that industrial employees, who even as late as the 40's used the bus, elevated, street car, or subway for their journey to work, particularly in larger metropolitan areas, are now relying on the private auto for transportation to suburban plants, labs, and warehouses. The reliance on the auto is particularly strong in the southeast where urbanization is less concentrated and more recent. Freeways have been a significant factor for new plant sites for over a decade. Prime industrial land, defined in the past by the availability of rail service, is now at least equally defined by frontage on or proximity to the freeway system.

The importance of transportation as a guidance instrument of local government is limited, however, because the investment decisions most important to the industrial firm, are those concerning the regional transportation system, and these decisions are made at the Federal and state levels. Nevertheless local government can coordinate industrial zoning with freeway capacity. This does not suggest continuous industrial zoning along both sides of the highways, however. Too great a concentration of industrial employment would overload freeway interchanges, thereby detracting from the major advantage of the freeway system to industry--fast, safe, and uninterrupted travel for employees and for trucks delivering raw materials and distributing the output products. At the smaller scale of the individual industrial district sites, transportation planning needs to consider the connecting roads from the site to the freeway system.

Incentives

Taxation. Many state constitutions permit local governments to exercise home rule options in assessing the value of property and some states permit localities to legally offer tax concessions in the form of reduced assessments to industry specifically. (Bridges, 1965a, p. 8) Some local governments will offer low assessments as an incentive to firms even where these exemptions are illegal.

While local tax exemptions may be appreciated and welcomed by the firm or perhaps even negotiated by the firm, the evidence suggests the impact is not large enough to significantly affect the location of the firm. A year ago, in the preceding version of this course, James Wilde noted that "the differential

in tax burdens among the various state and local governments is usually not large enough to be an important cost factor for many firms." (Wilde, 1971, p. 18) Furthermore, since industry ordinarily requires high service levels from local government, exemptions, if broad enough, could reduce the community's ability to provide these services and reduce its ability to attract new industrial development. Given their limited impact and their potential backlash, tax concessions have questionable merit in a local urban development guidance system.

Loans and Loan Guarantees. Some communities around the nation offer specific financial incentives to plants to attract them to their community. These include loan guarantees or direct loans financed through the issue of tax-free general obligation bonds, or bonds floated by a local or state development corporation. The Investment Banker's Association estimated the volume of state and local industrial aid bonds to be $200 million in 1960, and as high as $1.8 billion in 1968. (Thompson, 1969, p. 189) However, the evidence seems to suggest that "inducements are certainly a secondary factor in the choice of a region and are probably also a secondary factor in the choice of a location within a region." (Bridges, 1965, p. 142; Wallace and Ruttan, 1961, p. 142; and Thompson, 1969, p. 199)

Encouraging an attractive environment. Less direct, perhaps, but still an important inducement for industrial development, is the maintenance of a high quality environment for living. This point is stressed over and over again in interview surveys. Some go as far as calling it the single most important asset of a community for attracting a diversified industrial base (San Diego, 1970). Actions that detract from the quality of the environment even

though it might offer a handsome short run economic gain for the community, would be a serious detriment to the long range economic health of the community. The factors that contribute to or detract from the overall quality of life and of the physical setting are numerous.

Among them are:

* practices of massive grading in relation to land development;
* the proliferation of outdoor advertising signs and grotesque business identification signs
* the rate at which overhead power distribution lines are being put under ground
* the disappearance of valuable open space, natural terrain features.
* the amount and quality of land scaping along the streets, in neighborhood parks, on school sites, and throughout the city's residential neighborhoods.
* the exercise of air and water pollution controls
* the quality of design in public buildings
* the rate of renewal, conservation, and rehabilitation of deteriorating sections of the city
* the quality of education. (adapted from San Diego, 1970, pp. 142-143)

Thus an industrial development study may recommend:

> "that all emphasis possible be placed on preserving and enhancing the natural and manmade attributes of (our city), including: the preservation of open space and natural beauty; preservation and enhancement of (beach areas and marshes); control of air, water, odor, noise, and visual pollution; retention and expansion of recreational facilities; and the encouragement of high standards of design and beauty in all physical improvements undertaken within the City." (San Diego, 1970, p. 143)

Industrial Development Organizations. Although not normally a formal part of local government, industrial development organizations could be a part of the

community's industrial development guidance system if working relationships and cooperation existed between these organizations and local governmental officials. The organization could serve as a link between prospective industrial firms and the city's land and service resources. It could provide meaningful information to prospective firms, coordinate local programs and activities to meet the needs of prospective firms, and make assessments of the potential impact of the prospective industrial development on the public welfare of the community. In short, its main contribution might be a systematic approach to industrial development at a local or metropolitan level. Such an approach could aim to insure greater compatibility between industry and the community's existing and planned resources, employment needs, and environmental concerns.

IV. Planner as Evaluator

In addition to his role as the main designer of the long range future land use pattern, and in addition to his role in formulating the community's land development guidance system, the urban land use planner is sometimes the resident governmental analyst along with personnel in the Finance and Budget Department. As such he will sometimes do cost/revenue studies, particularly with regard to public investment in capital improvement and their locations. Thus the local land use planner may have a role to play in assessing the cost/revenue impact as well as economic, environmental, and urban growth impacts of industrial development schemes.

A review of available cost/revenue studies will reveal that industrial investment produces for local government a positive ratio of revenues to costs of from 3 to 1 to 5 to 1. (U. S. Department of Commerce, 1967) This is when

based on a comparison of revenues accruing directly from the new establishment with costs of services directly chargeable to it. The outcome is much less clear when the evaluations also include less direct costs and revenues attributable to the secondary industrial, residential, and commercial development stimulated by the initial industrial development being assessed.

The fiscal impact on local government will depend on a number of factors:

(1) Assessed value of the industrial investment: (land, plant, equipment and inventory) Assessed value appears to vary widely between industries and even between firms within industries. In general, of course, the higher the investment in capital per employee, the more favorable the cost/revenue ratio. The greater the tax incentive granted to attract industry, the poorer the ratio: (U. S. Department of Commerce, 1967; Isard and Coughlin, 1957)

(2) The demands on public services, particularly water and sewerage, and particularly if the demands will exceed present capacity and involve large new capital expenditures. "Some communities have undertaken heavy financial burdens to provide water supplies far in excess of normal needs in the expectation that such supplies would attract industry. Too often these water supplies have to be financed by general obligation debt which pushes the tax rate above a competitive level. To accommodate 22% of the firms interested in water they have reduced their capacity to attract 78% of the firms where this is not a prime consideration." (McMillan, 1965) This signals caution in seeking industry in

ways that raise local governmental tax rates.

Local government's policies regarding the distribution of capital improvement costs have considerable effect on the net cost/revenue picture. In some areas, off-site and on-site improvements, such as those for streets, sidewalks, water and sewer lines in the industrial subdivision or in housing development stimulated by the new jobs must be met by the developer. Since these expenditures become a part of the assessed value of the developed properties, local government, in effect, benefits twice -- capital expenditures are transferred to the private sector and property tax revenues are increased. In other areas government shares some of these costs. To the extent that local government shoulders costs of capital improvements implied by industrial development, the cost/revenue picture is worsened. (Isard and Coughlin, 1957; U. S. Department of Commerce, 1967)

3) The proportion of employees establishing residence in the area: In allocating government costs and revenues for local government in most states, the largest cost item is education. The net revenues generated by a new industry decreases as the percent of employees establishing new residence in the community increases. (Isard and Coughlin, 1957; U. S. Department of Commerce, 1967)

4) Average earnings per employee: As household income increases, investment for housing tends to increase. Thus property tax revenue accruing from new residences should be higher for high wage industries

than those for low wage industries. Also, higher income implies high local consumer expenditure.

Exclutionary zoning is sometimes used to assure limitation of the proportion of employees establishing residence in the area to the higher end of the new industry's salary and wage range.

(5) The average income and level of services in the community -- The impact of industrial development on revenue rates (hypothetical tax rates) is greatest upon those communities which are low-income with a medium level of service, or medium income with a high level of service. In such communities, revenue obtainable from industry is of greater relative importance than in communities with an already higher tax base, or who have lower costs because of lower levels of public services, or both. Also the assumptions about assessed value of industrial property, average earnings, and demand for public services by the industry are more important to such communities, the magnitude of variation in tax rate they imply is twice that of communities of higher income or very low service level. (Isard and Coughlin, 1957)

(6) Size of industrial development -- smaller industrial development regardless of type has little effect on tax rates; the introduction of a large industrial district can have a significant effect (reducing the tax rate from 4 - 10 mills in one study). (Isard and Coughlin, 1957)

(7) Spatial distribution of the industrial development -- a study of Greensboro, North Carolina showed that a well dispersed industrial land use pattern provides the most favorable cost/revenue ratio. The basic economy underlying the desirability of a dispersed pattern is that by diffusing the work trip traffic the street system may be more fully utilized. (Longabaugh, 1960)

V. Summary

Physical planning for economic growth, can help create a generally favorable climate for industrial development and at the same time provide guidelines for the community to control the nature and location for such development.

More specifically your local planning agency can:

(a) provide a future oriented policy statement in the form of a land use plan or comprehensive plan. Such a plan provides guidelines for sound economic development by identifying land best suited for industrial use on the basis of general community welfare objectives and by suggesting development standards to protect those objectives.

(b) provide, as a by-product of the land use planning process, a valuable information center for public and private decision makers, including industrial development agencies. This information base includes data on existing industrial plants (including land area, floor space, employment, products, and information on traffic and site planning problems); relatively unbiased and current data on vacant industrially zoned land (including information on land area, access to the regional transportation network and to utilities, capacity of utility services, adjacent land uses); zoning and development regulation restrictions applicable to the land; data on population and labor force, and data on schools and other public facilities.

(c) participate in the formulation of the guidance instruments that intervene more directly in the industrial development decision process. These instruments fall into one of three types: regulations, public investments

and incentives. Zoning, for example, can help reserve an appropriate land supply for future industrial development and help control its impact on the community.

(d) participate in the analysis of the impact of industrial development alternatives on the economic structure, governmental fiscal balance, urban activity pattern and physical environmental quality of the community.

At the risk of oversimplification, I will suggest that the urban land use planner may think that the industrial development professional lives by the credo, "bigger is better." The planner's "review of the stated objectives of existing industrial development agencies, whether at the regional, state, or community level, reveals (to the planner) a preoccupation with economic growth in terms of number of jobs. In its simplest form this objective involves the creation of manufacturing payrolls in an area as a means of providing employment and income for the population, and business for the service sector of the local economy." (U. S. Department of Commerce, Economic Development Administration, 1967, p. 87).

This objective is sound as far as it goes. The land use planner recognizes that manufacturing and wholesaling provide not only jobs and income, but also tend to expand the size of the local markets, which in turn provide the base for additional development, and so on. But land use planning is more fundamentally an attempt to accompany economic growth with improvement in community welfare, i.e., with increased per capita income, a healthy and livable physical environment, with an efficient and livable spatial pattern of land uses, and

with efficient (least cost) provision of public services. The land use planner is almost totally interested in "better" rather than "bigger." Perhaps by working together the planning and industrial development professions can help to assure that economic development does in fact lead to a better community as well as a "bigger" one.

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SPEECH BEFORE

UNITED NATIONS INDUSTRIAL DEVELOPMENT COMMITTEE

By

Robert E. Leak, Administrator
Office of Industrial, Tourist and Community Resources
Department of Natural and Economic Resources
State of North Carolina
Raleigh, North Carolina

Ladies and Gentlemen:

I am pleased to be with such an outstanding group of international development people. I believe my appearance before you is perhaps the highlight of my 12 year career as a State development official. As you have heard, I am also involved in the Travel Promotion effort of our State. So let me officially welcome you to North Carolina. We know tourism is our second largest industry. We have a beautiful State and I hope that you will have time to see it while you are in this country.

I believe that the idea of an International Committee on Industrial Development is excellent. There are many multi-national industries in the world today, and many industrial problems tend to be international problems. Many states and nations have pioneered ways to solve development problems. There is a great need for us to share this information for our mutual benefits.

It is most appropriate that you are meeting in the Southern United States. The South is the most recent area of the U. S. to emerge from an agricultural economy to an industrial economy. The South is really a textbook example of industrial development. Each of the Southern States has instituted a most aggressive state development program and North Carolina's program is the leader. Ours was the first state in the U. S. to have a state industrial development activity-having started the program in 1935 and we have grown into a most extensive and effective Division of State Government.

The textbook example of industrial development I referred to was created because the South had to start all over again with its development after the War Between the States just over 100 years ago.

Prior to the War, the settlers of the South staked their energies, hopes and fortunes on commercial agriculture-tobacco for the British market and later cotton for Northern U. S. mills. The society that was forming was plantation oriented with money and power being concentrated in the hands of relatively small group in the upper strata of the social structure.

All of the Southern states had common characteristics:

> Low Income due to low productivity and specialization in technologically backward types of production typical on the plantations. A low and unbusinesslike utilization of capital.
>
> High proportion of diadvantaged slaves and other farm laborers in the population with no educational opportunities and very low achievement standards as human beings.

Even though some meager attempts at industrialization occurred prior to the War, the South still embraced agriculture as the mainstay of the Southern economy. Perhaps it was more socially acceptable to the elite to be gentleman farmers rather than manufacturers. Certainly, it was easier, and Southerners have been characterized as basically lazy people supposedly because of the hot and humid weather conditions prevailing in the region.

When the South decided to defend its way of life and seceded from the Union in 1860 and became engaged in war with the industrialized North, a historical lesson was learned by all of mankind-an agricultural nation cannot win a war with an industrialized nation without outside assistance.

After the War, the South had learned its tragic and costly lesson, industrialization thus became a religious crusade. But industrialization did not occur rapidly. It came slowly and paintakenly because of the following problems and these are textbook problems.

1. A tenacity to the plantation style of doing business
2. A paternalistic attitude on the part of employers toward labor

3. Low capitol accumulation-a bankrupt region
4. Differential freight rates between North and South which amounted to a tariff barrier
5. Cheap and unskilled labor
6. No markets in the South because the people didn't have buying power
7. Very poor image as a backward region
8. Very unstable political situation

The South did not emerge as an industrial area until the mid 1950's because it had taken the South nearly one hundred years to overcome the problems I have just mentioned. Fortunately, we have become industrialized and the quality of life of the people has been enhanced because of that fact. The South is now the new frontier for more industry and I think we are doing a better job of developing than was done in the North. The reason for this is that we have learned a great deal in our formulative years. We have been able, in the South, to take a close examination of the old industrialized areas of our country and have made more favorable development decisions as a result. We have tried not to make the mistakes they made. I would like to share with you some of the things we have learned.

First of all, our State does not have huge deposits of coal and metal ore which is necessary to support basic industry. Our major natural resource is wood and fibre and we lead the nation in the production of wooden household furniture and textiles. Wood and fibre can be converted to useful products without driving off harmful gasses and particles into the air or water which is not the case with coal, oil and ores. So my first lesson is that if your country has major deposits of coal, oil, and ores then you must be extremely careful not to allow these resources to be converted without proper environment protection laws. Also an overconcentratio of industry in any relatively small geographic area is potentially crushing to the fragile ecosystems of that area.

This is the great problem inherent to most port cities of the world. The great harbors of Rotterdam, Hong Kong and New York, as well as many others, are dramatic testamonies of the danger the environment faces in areas of over-concentration of production because of an ease of transportation.

My second lesson, therefore, is this: The more attractive your port the greater the danger of ruinous overdevelopment. Growth management environmental plans must be made to control growth in these areas.

Another reason our State has fewer problems than most is because our State has led the nation in the construction of paved roads. This network for transportati has allowed for the development of small communities and has held down the develc ment of the huge, uncontrollable urban centers, and because of their rural heritage, the majority of our people still prefer to live outside of town.

My third lesson is this: Small community action plans should be developed to prevent the rapid urbanization of your population into centers which become uncontrollable, ungovernable and unfinanciable.

Other things we have learned is that -

1. Land use planning must proceed development or urbanization gets out of control and cities sprawl endlessly.

2. Industry wants to be treated fairly and wants to feel wanted. A vigorous promotion program by the state or local government is important and fair treatment of industry by government is important to preserving a good business climate.

3. Cheap labor will attract industry-and not necessarily desirable industry. If the labor rates in your area are substantially below the world averages, then the rapid influx of new industry may produce <u>many</u> problems while only solving a <u>few</u>.

4. Environmental laws are necessary and proper and should be sufficiently tough to prevent pollution problems. Establish reasonable requirements and then enforce them fairly and avoid changing the requirements after they are established, if at all possible. Do not lower pollution control standards as an inducement to industry. Don't be all regulatory but also give help to industry in their efforts to comply.

The economic development effort of our State government has enjoyed a great reputation over the years because of its effectiveness. Since its creation in 1935, our development division has been housed in the same Department with the conservation divisions. Our State developers have been more aware of the environment than the developers of most states. I heartily recommend this procedure and suggest that you involve government conservationists in the work of your government developers and vice versa.

My State has decided that it is a state government's responsibility to provide skill development training to our people so they will qualify for skilled jobs being offered them by industry. This is a free program and is the major inducement this State offers. I highly recommend the plan to your consideration.

I don't have to tell you, ladies and gentlemen, about the competition which exists between towns, states, regions and nations for attractive industrial development projects. The more attractive the industry, the more severe the competition. It would be a tragic mistake, I believe, for any town, state, region or nation to offer an industry a "no controls" or a "freedom to pollute" situation as an inducement to achieve the location of the plant. Any entity pursuing this philosophy will be trading its misery of joblessness for an equally miserable reduction in the natural quality of life. For underdeveloped towns, states, regions and nations let there be other inducements for development such as financial and tax incentives, government sponsored worker training programs, speculative industrial building plans, new town developments, etc.

Let's don't, any of us, sacrifice Mother Nature on the altar of economic development.

Thank you for your kind attention.

****

Approved under O.M.B. No. 038-R0182

U.S. ATOMIC ENERGY COMMISSION

REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

REGULATORY GUIDE 4.2

PREPARATION OF ENVIRONMENTAL REPORTS FOR NUCLEAR POWER PLANTS

MARCH 2, 1973

USAEC REGULATORY GUIDES

Regulatory Guides are issued to describe and make available to the public methods acceptable to the AEC Regulatory staff of implementing specific parts of the Commission's regulations, to delineate techniques used by the staff in evaluating specific problems or postulated accidents, or to provide guidance to applicants. Regulatory Guides are not substitutes for regulations and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.

Published guides will be revised periodically, as appropriate, to accommodate comments and to reflect new information or experience.

Copies of published guides may be obtained by request indicating the divisions desired to the U.S. Atomic Energy Commission, Washington, D.C. 20545, Attention: Director of Regulatory Standards. Comments and suggestions for improvements in these guides are encouraged and should be sent to the Secretary of the Commission, U.S. Atomic Energy Commission, Washington, D.C. 20545, Attention: Chief, Public Proceedings Staff.

The guides are issued in the following ten broad divisions:

1. Power Reactors
2. Research and Test Reactors
3. Fuels and Materials Facilities
4. Environmental and Siting
5. Materials and Plant Protection
6. Products
7. Transportation
8. Occupational Health
9. Antitrust Review
10. General

TABLE OF CONTENT

	Page
INTRODUCTION	4.2-1
National Environmental Goals	-1
Applicant's Environmental Reports	-1
Appendix D of 10 CFR Part 50	-1
Federal Water Pollution Control Act	-2
Commission Action on Environmental Reports	-2
General Considerations Relating to Environmental Reports	-3
Cost-Benefit Analysis	-3
Construction Permit and Operating License Stages	-3
Preparation of Environmental Reports	-4
General Organization	-4
Content	-4
Other Facilities at a Site	-5
STANDARD FORMAT AND CONTENT OF ENVIRONMENTAL REPORTS FOR NUCLEAR POWER PLANTS	
1. PURPOSE OF THE PROPOSED FACILITY	4.2-6
1.1 Need for power	-6
1.1.1 Load characteristics	-6
1.1.2 Power supply	-6
1.1.3 Capacity requirement	-7
1.1.4 Statement on area need	-7
1.2 Other objectives	-7
1.3 Consequences of delay	-7
2. THE SITE	4.2-8
2.1 Site location and layout	-8
2.2 Regional demography, land and water use	-8
2.3 Regional historic, scenic, cultural and natural landmarks	-9
2.4 Geology	-9
2.5 Hydrology	-9
2.6 Meteorology	-10
2.7 Ecology	-10
2.8 Background radiological characteristics	-10
2.9 Other environmental features	-11
3. THE PLANT	4.2-12
3.1 External appearance	-12
3.2 Reactor and steam-electric system	-12
3.3 Plant water use	-12
3.4 Heat dissipation system	-12
3.5 Radwaste systems	-12
3.6 Chemical and biocide wastes	-13
3.7 Sanitary and other waste systems	-13
3.8 Radioactive materials inventory	-13
3.9 Transmission facilities	-14

Page

4. ENVIRONMENTAL EFFECTS OF SITE PREPARATION, PLANT AND TRANSMISSION FACILITIES CONSTRUCTION 4.2-15

4.1 Site preparation and plant construction ..... -15
4.2 Transmission facilities construction ..... -16
4.3 Resources committed ..... -16

5. ENVIRONMENTAL EFFECTS OF PLANT OPERATION 4.2-17

5.1 Effects of operation of heat dissipation system ..... -17
5.2 Radiological impact on biota other than man ..... -18
5.2.1 Exposure pathways ..... -18
5.2.2 Radioactivity in environment ..... -18
5.2.3 Dose rate estimates ..... -18
5.3 Radiological impact on man ..... -19
5.3.1 Exposure pathways ..... -19
5.3.2 Liquid effluents ..... -19
5.3.3 Gaseous effluents ..... -19
5.3.4 Direct radiation ..... -20
5.3.4.1 Radiation from facility ..... -20
5.3.4.2 Transportation of radioactive materials ..... -20
5.3.5 Summary of annual radiation doses ..... -20
5.4 Effects of chemical and biocide discharges ..... -20
5.5 Effects of sanitary and other waste discharges ..... -21
5.6 Effects of operation and maintenance of the transmission system ..... -21
5.7 Other effects ..... -21
5.8 Resources committed ..... -21
5.9 Decommissioning and dismantling ..... -21

6. EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS 4.2-23

6.1 Applicant's pre-operational environmental programs ..... -23
6.1.1 Surface waters ..... -23
6.1.2 Ground water ..... -24
6.1.3 Air ..... -24
6.1.4 Land ..... -25
6.1.5 Radiological surveys ..... -25
6.2 Applicant's proposed operational monitoring programs ..... -25
6.2.1 Radiological monitoring ..... -25
6.2.2 Chemical effluent monitoring ..... -26
6.2.3 Thermal effluent monitoring ..... -26
6.2.4 Meteorological monitoring ..... -26
6.2.5 Ecological monitoring ..... -26
6.3 Related environmental measurement and monitoring programs ..... -26

7. ENVIRONMENTAL EFFECTS OF ACCIDENTS 4.2-27

7.1 Plant accidents involving radioactivity ..... -27
7.2 Other accidents ..... -32

8. ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION 4.2-33

8.1 Benefits ..... -33
8.2 Costs ..... -34

Page

9. ALTERNATIVE ENERGY SOURCES AND SITES 4.2-35

9.1 Alternatives not requiring the creation of new generating capacity ..... -35
9.2 Alternatives requiring the creation of new generating capacity ..... -35
9.2.1 Selection of candidate areas ..... -35
9.2.2 Selection of candidate site-plant alternatives ..... -36
9.3 Cost-effectiveness comparison of candidate site-plant alternatives ..... -37

10. PLANT DESIGN ALTERNATIVES 4.2-38

10.1 Cooling system (exclusive of intake and discharge) ..... -40
10.2 Intake system ..... -40
10.3 Discharge system ..... -40
10.4 Chemical waste treatment ..... -40
10.5 Biocide treatment ..... -40
10.6 Sanitary waste system ..... -40
10.7 Liquid radwaste systems ..... -40
10.8 Gaseous radwaste systems ..... -40
10.9 Transmission facilities ..... -40
10.10 Other systems ..... -40

11. SUMMARY BENEFIT-COST ANALYSIS 4.2-42

12. ENVIRONMENTAL APPROVALS AND CONSULTATIONS 4.2 43

13. REFERENCES 4.2-43

TABLES

Table 1 Benefits from the Proposed Facility 4.2-46
Table 2 Monetized Bases for Generating Costs ..... -47
Table 3 Environmental Factors to be Used in Comparing Alternative Plant Systems .... -48
Table 4 Basic Tabulation to be Used in Comparing Alternative Plant Systems ..... -58
Table 5 Basic Tabulation to be Used in Comparing Alternative Transmission Routes ... -62
Table 6 Cost Description of Proposed Facility and Transmission Hookup ..... -64

APPENDICES

1. Questionnaire for Eliciting Data for Radioactive Source-Term Calculations 4.2-69

2. Example of Charts Showing Radiation Exposure Pathways 4.2-72

INTRODUCTION

NATIONAL ENVIRONMENTAL GOALS

Prior to the issuance of a construction permit or an operating license for a nuclear power plant, the U.S. Atomic Energy Commission is required to assess the potential environmental effects of that plant in order to assure that issuance of the permit or license will be consistent with the national environmental goals, as set forth by the National Environmental Policy Act of 1969 (Public Law 91-190). In order to obtain information essential to this assessment, the Commission requires each applicant for a permit or a license to submit a report on the potential environmental impacts of the proposed plant and associated facilities.

The national environmental goals as expressed by the National Environmental Policy Act (NEPA) are as follows:

> "...it is the continuing responsibility of the Federal Government to use all practical means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may–
>
> "(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
> "(2) assure for all Americans safe, healthful, productive and esthetically and culturally pleasing surroundings;
> "(3) attain the widest range of beneficial use of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
> "(4) preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice;
> "(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
> "(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

The Commission's implementation of NEPA is contained in Appendix D of 10 CFR Part 50.

APPLICANT'S ENVIRONMENTAL REPORTS

Appendix D of 10 CFR Part 50

The revised Appendix D of 10 CFR 50 discusses, in the first five paragraphs of Section A, the required content of the Environmental Reports to be submitted by the applicant:

> "1. Each applicant[1] for a permit to construct a nuclear power reactor...shall submit with his application three hundred copies...of a separate document, entitled 'Applicant's Environmental Report–Construction Permit Stage,' which discusses the following environmental considerations:
>
> "(a) the environmental impact of the proposed action,
> "(b) any adverse environmental effects which cannot be avoided should the proposal be implemented,
> "(c) alternatives to the proposed action,
> "(d) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
> "(e) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.
>
> "2. The discussion of alternatives to the proposed action in the Environmental Report required by paragraph 1 shall be sufficiently complete to aid the Commission in developing and exploring, pursuant to section 102(2)(D) of the National Environmental Policy Act, 'appropriate alternatives...in any proposal which involves unresolved conflicts concerning alternative uses of available resources.'
>
> "3. The Environmental Report required by paragraph 1 shall include a cost-benefit analysis which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects, as well as the

[1] Where the "applicant", as used in the Appendix, is a Federal agency, different arrangements for implementing the National Environmental Policy Act may be made, pursuant to the guidelines established by the Council on Environmental Quality.

environmental, economic, technical and other benefits of the facility. The cost-benefit analysis shall, to the fullest extent practicable, quantify the various factors considered. To the extent that such factors cannot be quantified, they shall be discussed in qualitative terms. The Environmental Report should contain sufficient data to aid the Commission in its development of an independent cost-benefit analysis covering the factors specified in this paragraph.

"4. The Environmental Report required by paragraph 1 shall include a discussion of the status of compliance of the facility with applicable environmental quality standards and requirements (including, but not limited to, thermal and other water quality standards promulgated under the Federal Water Pollution Control Act) which have been imposed by Federal, State and regional agencies having responsibility for environmental protection. In addition, the environmental impact of the facility shall be fully discussed with respect to matters covered by such standards and requirements irrespective of whether a certification from the appropriate authority has been obtained (including, but not limited to, any certification obtained pursuant to section 21(b) of the Federal Water Pollution Control Act[2]). Such discussion shall be reflected in the cost-benefit analysis prescribed in paragraph 3. While satisfaction of AEC standards and criteria pertaining to radiological effects will be necessary to meet the licensing requirements of the Atomic Energy Act, the cost-benefit analysis prescribed in paragraph 3 shall, for the purposes of the National Environmental Policy Act, consider the radiological effects, together with the thermal effects and other environmental effects, of the facility.

"5. Each applicant for a license to operate a production or utilization facility described in paragraph 1 shall submit with his application three hundred (300) copies . . . of a separate document to be entitled 'Applicant's Environmental Report–Operating License Stage,' which discusses the same environmental considerations described in paragraphs 1-4, but only to the extent that they differ from those discussed in the Applicant's Environmental Report previously submitted in accordance with paragraph 1. The 'Applicant's Environmental Report–Operating License Stage' may incorporate by reference any information contained in the Applicant's Environmental Report previously submitted in accordance with paragraph 1. With respect to the operation of nuclear power reactors, the applicant, unless otherwise required by the Commission, shall submit the 'Applicant's Environmental Report–Operating License Stage' only in connection with the first licensing action that would authorize full-power operation of the facility,[3] except that such report shall be submitted in connection with the conversion of a provisional operating license to a full-term license."

In fulfilling the requirement for submission of three hundred (300) copies of the Environmental Report, applicants are requested to furnish two hundred (200) copies with the application and to hold one hundred (100) copies subject to call by the Commission.

Federal Water Pollution Control Act

As provided in the "Interim Policy Statement" published on January 29, 1973 (38 F.R. 2697), the recently enacted Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500, 86 Stat. 816 (FWPCA) will affect the Atomic Commission's responsibilities under the National Environmental Protection Act of 1969 (NEPA). The Commission's NEPA responsibilities will be modified as various implementing actions are taken under the new FWPCA and appropriate changes will be made in this Guide However, since the Commission will, in any event, continue to evaluate environmental impact, the basic scope and content of the information needed to prepare an Environmental Report, as set forth in this Guide, will remain unchanged.

COMMISSION ACTION ON ENVIRONMENTAL REPORTS

As noted in paragraph 6 of Section A of the revised Appendix D of 10 CFR 50, the Commission places each applicant's Environmental Report in the AEC's Public Document Room in Washington, D.C. and in a local public document room near the proposed site. The Report is also made available to the public at the appropriate State, regional and metropolitan clearinghouse. At the same time, a public announcement is made and a summary notice published in the *Federal Register.*

The applicant's Environmental Report, relevant published information, and any comments received from interested persons are considered by the Commission's regulatory staff in preparing a "Draft Detailed Statement of Environmental Considerations" concerning the

[2] No permit or license will, of course, be issued with respect to an activity for which a certification required by section 21(b) of the Federal Water Pollution Act has not been obtained.

[3] This report is in addition to the report required at the construction permit stage.

proposed licensing action. The regulatory staff's Draft Statement and the applicant's Environmental Report are transmitted for comment to the Council on Environmental Quality, to Federal agencies having jurisdiction by law or special expertise or who are authorized to develop and enforce environmental standards, and "to the Governor or appropriate State and local officials, who are authorized to develop and enforce environmental standards, of any affected State." Comments on the Report and the Draft Statement are requested within a specified time interval. The Draft Statement is made available to the general public in the same manner as the Report.

As described in detail in paragraphs 6 through 9 of Section A of the revised Appendix D, the regulatory staff considers the comments on the Report and on the Draft Statement received from the various Federal, State, and local agencies and officials, from the applicant, and from private organizations and individuals, and prepares a "Final Detailed Statement on the Environmental Considerations." The Final Statement is transmitted to the Council on Environmental Quality and is made "available to appropriate Federal, State and local agencies and State, regional, and metropolitan clearinghouses." A public announcement is made and a notice of availability published in the *Federal Register*.

Subsequent hearings and action on the environmental aspects involved in issuance of a construction permit or operating license are based on the Commission's Final Environmental Statement. The Environmental Statement takes into account information from many sources, including the applicant's Environmental Report and its supplements, and the comments of the various governmental agencies, the applicant, and private organizations and individuals.

The applicant's Environmental Report is an important document of public record. Therefore, the applicant is urged to give full attention to the completeness of the Report.

GENERAL CONSIDERATIONS RELATING TO ENVIRONMENTAL REPORTS

Cost-benefit analysis

The cost-benefit analysis referred to in paragraph 3 of Section A, Appendix D of 10 CFR Part 50, should consist of two parts.

In the first part, alternative site-plant combinations and plant systems are to be examined in order to determine whether the proposed facility is the cost-effective choice, considering economic, social and other environmental factors, and any institutional (governmental, etc.) constraints. Because the benefit associated with each alternative will be essentially the same, cost-effectiveness analysis of the alternatives is recommended.

In the second part, the benefits to be created by the proposed facility should be weighed against the aggregate of environmental, economic and other costs to be incurred.

Construction permit and operating license stages

As is clear from paragraph 5 of Section A, Appendix D of 10 CFR Part 50, two Environmental Reports are required. The first is the "Applicant's Environmental Report–Construction Permit Stage" which must be submitted in conjunction with the construction permit application. The second is the "Applicant's Environmental Report–Operating License Stage," which must be submitted later in conjunction with the operating license application.

The "Applicant's Environmental Report–Construction Permit Stage" should include as much of the information as set forth in this Guide as practicable. It is recognized, however, that some of the information may not be available to the applicant at the time of submission of the Report. In such cases, the applicant should provide the information that is available, state when the remaining information is expected to become available, and, where specific studies are required to obtain the information, describe plans for these studies. Where the missing information pertains to an environmental effect of construction of the proposed facility, the applicant should provide and justify the basis for estimating that effect, based on information available at the time of filing.

In general, before a construction permit can be issued, the important environmental characteristics of the site and the major prospective environmental impacts of site preparation and plant construction should be established. The applicant's plans to mitigate undesirable environmental impacts of site preparation and plant construction should also be developed prior to construction permit issuance. In those instances where such activities could potentially cause an unusual or substantial impact that warrants specific attention or control, the construction permit may include conditions, limits or monitoring requirements in order to assure that specified environmental impacts are controlled.

The "Applicant's Environmental Report–Operating License Stage" is, in effect, to be an updating of the first one and should:

a. Discuss differences between currently projected environmental effects of the nuclear power plant (including those which would degrade and those which would enhance environmental conditions) and the effects discussed in the Environmental Report submitted at the construction stage.

(Differences may result, for example, from changes in plans, changes in plant design, availability of new or more detailed information, or changes in surrounding land use, water use, or zoning classifications.)

b. Discuss the results of all studies which were not completed at the time of pre-construction review and which were specified to be completed before the pre-operational review. Indicate how the results of these studies were factored into the design and proposed operation of the plant.

c. Describe in detail the monitoring programs which have been and will be undertaken to determine the effects of the operating plant on the environment. Include any monitoring programs which are being developed or carried out in cooperation with State and Federal fish and wildlife services. The results of preoperational monitoring activities should be presented. A listing of types of measurements, kinds, and numbers of samples collected, frequencies, and analyses should be provided and the locations described and indicated on a map of the area.

d. Discuss planned studies, not yet completed, that may yield results relevant to the environmental impact of the plant.

e. Propose technical specifications relating to environmental impact. The proposed "Environmental Technical Specifications" will define the operating limits important to the protection of the environment and will specify the monitoring and surveillance programs, as well as the administrative procedures and controls, necessary to assure compliance. Guidelines for the preparation of Environmental Technical Specifications will be incorporated in a future edition of this Guide. In the interim, guidance will be furnished by the regulatory staff to individual applicants for operating licenses.

PREPARATION OF ENVIRONMENTAL REPORTS

General organization

The second Section of this Introduction, with particular reference to the paragraphs quoted from the revised Appendix D of 10 CFR 50, provides general information concerning the content of the applicant's Environmental Report. To provide specific and detailed guidance, the following "Standard Format and Content of Environmental Reports for Nuclear Power Plants" has been prepared. While conformance is not required, the format and content described are acceptable to the regulatory staff. Environmental Reports with differing formats or content will be acceptable to the staff if they provide an adequate basis for the findings required for the issuance of a license or permit; however, conformance with the format and content will expedite staff review.

Content

In order to cover a wide variety of anticipated situations, the Guide scope is comprehensive. In some instances, requests for specific information may not be applicable to a particular plant or site.

Some of the Guide text (e.g., Section 7.1) has been written with specific reference to light-water reactors. Guidelines on the recommended content of these sections will be provided, on a case-by-case basis, to applicants proposing to construct and operate other reactor types.

Some of the information to be included in the Environmental Report (e.g., that pertaining to demography, meteorology, hydrology) may have already been prepared by the applicant during consideration of the safety aspects of the proposed facility. In such cases, this information (whether in the form of text, tables or figures) should be incorporated in the Environmental Report where appropriate to avoid duplication of effort. The presentation in the Environmental Report of some information which also appears in the applicant's Safety Analysis Report is necessary because these reports are responsive to different statutory requirements and because each report should be essentially self-contained.

Descriptive and/or narrative text as well as tables, charts, graphs, etc. should be used in the Report. Each subject should be treated in sufficient depth and should be documented[4] to permit a reviewer independently to evaluate the extent of the environmental impact. The exact length of the Environmental Report will depend on the nature of the plant and its environment. Tables, line drawings, and photographs should be used wherever contributory to the clarity and brevity of the Report. Descriptive and narrative passages should be brief and concise. The number of significant figures stated in numerical data should reflect the accuracy of the data.

Pertinent published information relating to the site, the plant, and its surroundings should be referenced. Where published information is essential for evaluation of specific environmental effects of the plant construction and operation, it should be included, in summary or verbatim form, in the Environmental Report or as an appendix to the Report. In particular, water quality standards and regulations relevant to the environmental impact assessment should be given in an appendix. Reports of work supported by the applicant which the applicant considers contributory to the environmental impact analysis may be included as appendices.

[4] "Documentation" as used in this Guide means presentation of evidence supporting data and statements and includes: (1) references to published information, (2) citations from the applicant's experience, (3) references to unpublished information developed by the applicant or the applicant's consultants. Statements not supported by documentation are acceptable provided the applicant identifies them either as information for which documentation is not available or as expressions of belief or judgment.

Other facilities at a site

The site for a nuclear power plant may already contain one or more "units" (i.e. steam-electric plants), either in being or under construction or for which an application for a construction permit or operating license has been filed. The applicant, in preparing the Environmental Report relating to such a site, should consider the effects of the proposed plant (and its in-service schedule) in conjunction with the effects of such additional plants. Further, if the site contains significant sources of environmental impact other than electric power plants, their interactions with the proposed plant should be taken into account.

1. PURPOSE OF THE PROPOSED FACILITY

In this Chapter, the applicant is to demonstrate the need for the proposed facility in terms of the power requirements to be satisfied, the system reliability to be achieved, any other primary objectives of the facility, and the consequences of delay in the scheduled operation of the proposed plant on those primary objectives.

1.1 Need for power

This Section should discuss the requirement for the proposed nuclear unit(s) in the applicant's system and in the region, considering the overall power supply situation, past load and projected load growth, reserve margins, and the reliability of the bulk power supply. Apparent inconsistencies between the data presented and that furnished to the Federal Power Commission or the regional reliability council should be explained.

1.1.1 Load characteristics

Items (a) through (c) below pertain to annual load data. This annual data should be provided, to the extent available, beginning ten years prior to the filing of the Environmental Report through at least two years beyond the projected initial date of commercial operation of the last nuclear unit with which the Report is concerned. The other load data, items (d) and (e), should be presented for the initial full year of operation of the proposed plant. In all cases, the data should be provided, for (1) the applicant's system, (2) the power pool or area within which the applicant's planning studies are based and (3) where available, the regional reliability council or appropriate subregion or area of the reliability council.

(a) The past annual peak load demands and energy requirements and future projected demands and energy requirements should be presented. The past and future growth trends should be compared and explanations given for deviations in trend. A discussion should be included as to the extent to which the future trend reflects anticipated decreases in demand resulting from actions that are in p or have been taken at the loc national level to conserve electric e

(b) The applicant should provide data f total interruptible load to the exten such load is used in power pla studies to reduce the annual demands or energy requirements.

(c) The past and expected future firr power purchase (or sales) applical the time of the annual peak de should be presented. The past expected future firm energy sales sl also be presented.

(d) Monthly peak and energy l interruptible peak and energy loads firm power peak and energy purc (or sales) as expected for the initia year of operation of the proj nuclear plant should be provided.

(e) The applicant should present expected annual load duration curv information derived from such a for the initial full year of operatic the proposed nuclear plant substantiate the need for base generation.

1.1.2 Power supply

The applicant should briefly discuss power planning programs and criteria as apply (1) to the applicant's system, (2) t power pool or area within which applicant's planning studies are based an the regional reliability council or appropriate subregion or area of the reliab council. Systems capabilities should tabulated for the three respective areas t extent applicable at the time of the an peak demand for five years preceding filing of the Environmental Report throug least two years beyond the expected in date of commercial operation of the nuclear unit with which the Report concerned. Each generator capability sh be listed separately for the initial year capability additions thereafter should separately tabulated by date including

non-firm power purchases (or sales), retirements or deratings, and upratings. Each generator should be categorized as to type (hydro, fossil, nuclear, pumped storage, etc.) and as to function (base load, intermediate, peaking, etc.)

1.1.3 Capacity requirement

The applicant's method of determining system generating capacity requirements should be described including:

(a) The method and criterion employed to determine the minimum system reserve requirement such as single largest unit, probability method or historical data and judgment. If probabilistic studies are used as a planning tool the results should be stated along with the significant input data utilized, such as the load model, generating unit characteristics (including forced outage rates and maintenance schedules), the duration of periods examined, treatment of interconnections, and a general description of the methodology employed.

(b) The effect of operation of the proposed nuclear unit(s) on the applicant's, or planning entity's capacity requirements. In addition, the effects of present and planned interconnections on the capacity requirements should be discussed.

(c) The reserve margin responsibility of participants in the regional coordinating council or power pool.

1.1.4 Statement on area need

The applicant should include any report(s) or statement(s), indicating the power requirement in the overall area(s), from responsible officials in the regional reliability council and/or the power pool or planning entity with which the applicant is associated.

The reports or statements should include the following information or a statement that such information is not available:

(a) description of the minimum installed reserve criterion for the region and/or subarea;

(b) identification, description and brief discussion of studies and/or analyses made to assess the area-wide adequacy and expected reliability of power supply for the first year of operation of the nuclear unit(s); and

(c) the minimum reserve requirement in the region and/or subarea for the first year of operation of the proposed nuclear plant.

1.2 Other objectives

If other objectives are to be met by the proposed facility, such as producing process steam for sale, or desalting water, a description of these should be given.

1.3 Consequences of delay

The effects of delays in the proposed project on the adequacy and reliability of the power supply for the applicant's system(s), subregion and region should be discussed.

2. THE SITE

This Chapter should present the basic, relevant information concerning those physical, biological, and human characteristics of the area environment that might be affected by the construction and operation of a nuclear power plant on the designated site. To the extent possible, the information presented should reflect observations and measurements made over a period of years.

2.1 Site location and layout

Provide a map[1] showing the coordinates of the site and its location with respect to State, county and other political subdivisions. On detailed topographical maps show location of the plant perimeter, exclusion area boundary, utility property, abutting and adjacent properties, including water bodies, wooded areas, and farms, nearby settlements, industrial plants, parks, and other public facilities, and transportation links (railroads, highways, waterways). Indicate total acreage owned by the applicant and that part occupied or modified by the plant and plant facilities. Indicate other existing and proposed uses, if any, of applicant's property and the acreage devoted to these uses. Describe any plans for site modifications, such as a visitors' center or park.

2.2 Regional demography, land and water use

Two maps indicating the locations and areas of towns and cities should be provided, with the first covering an area of 10-mile radius centered at the proposed plant location and the second covering an area of 50-mile radius. The 10-mile map should have circles, centered at the reactor building location, of 1, 2, 3, 4, 5, and 10 miles radius; on the 50-mile map, circles with radii of 5, 10, 20, 30, 40 and 50 miles should be drawn. The populations (year of most recent census) of the towns and cities shown on the maps should be indicated either on the maps or in a separate tabulation.

The circles of the above maps should be divided into 22.5° segments, with each segment centered on one of the 16 cardinal compass points (N, NNE, NE, etc.) For each of the sectors thus formed by the concentric circles and radial lines, the applicant should tabulate (on separate maps or tables) the permanent populations within the sector for the following: year of the most recent census, time of proposed plant startup, and end of the anticipated life of the plant. The basis for the population projections should be described.

The estimated permanent and/or transient population, at the time of start of plant construction, at plant startup, and at end of plant lifetime, of public facilities (schools, hospitals, prisons, recreation and sports facilities, etc.) within 5 miles of the plant should be presented. If the site includes a visitors' center, its location and anticipated visitor statistics should be provided.

Indicate (for the 5 mile radius area) the nature and extent of present and projected land use (agriculture, livestock raising, dairies, pasturelands, residences, industries, recreation, wildlife preserves, sanctuaries, hunting areas, transportation, etc.) and any recent trends such as abnormal changes in population or industrial patterns. If the area near the plant site is zoned for specific uses, the applicant should indicate the zoning restrictions, both at the site and within 5 miles of the reactor building location.

Indicate the nature and amounts of present water use (water supplies, irrigation, reservoirs, recreation, transportation, etc.) within the plant site and environs. The applicant should provide data concerning any drawdown of ground water caused by withdrawals from neighboring major industrial and municipal wells and how they may result in the transport of material from the site to those or other wells. All locations of water usage within 50 miles where the water supply may be contaminated by plant effluents, should be identified and the population associated with each use point given. In addition, all population centers taking water from waterways from the plant to the ocean, or such lesser distance as the applicant can technically justify, should be tabulated (distance, uses, amounts and population). Sources which are river bank wells should be tabulated separately with their associated population. In streams where radioactive contaminants may be introduced by plant operation, the applicant should estimate the minimum transit time and the minimum dilution of the contaminated water between the point of discharge and the points of use. Data, assumptions, and models used in estimating transit time and dilution should be provided.

[1] All maps requested in Chapter 2 should indicate distance scale and compass north (at least). Coordinates should be UTM. Site coordinate grid should also be presented.

Note on the maps the locations of industrial facilities, including power plants, which might release effluents (to the atmosphere or to waterways) that could interact with the proposed plant or with its effluents.

The degree of detail to be provided in any paragraph in this Section will generally depend upon the distance from the plant; that is, nearby activities (within 5 miles of the plant) should be described in greater detail than those at greater distances.

2.3 Regional historic, scenic, cultural and natural landmarks

Areas valued for either their historic, scenic, cultural or natural significance may be affected. The Environmental Report should include a brief discussion of the historic, scenic, cultural and natural significance, if any, of the plant site and nearby areas with specific attention to the sites and areas listed in the *National Register of Historic Places* and the *National Registry of Natural Landmarks.* The 1972 cumulative revision of the *National Register of Historic Places* is in the *Federal Register* of March 15, 1972, 37 F.R. 5428; additions are published in the *Federal Register* on the first Tuesday of each month. The *National Registry of Natural Landmarks* appears in the *Federal Register* of January 29, 1972. Also, the applicant should discuss its consultation with the appropriate State Liaison Officer for Historic Preservation concerning properties under consideration for nomination to the *National Register of Historic Places.* The Environmental Report should contain evidence of contact with the Historic Preservation Officer for the state involved and a copy of his comments concerning the effect of the undertaking on historic, archaeological and cultural resources. State Liaison Officers are listed in the *Federal Register* of March 15, 1972 and supplemented in December 1972. In addition, indicate whether or not the site has any archaeological significance and explain how conclusions were reached. If such significance or value is present, describe plans to ensure its preservation.

State whether the proposed transmission line right-of-way from the plant to the hook-up with existing system (Section 3.9) will pass through or near any area or location of known historic, scenic, cultural, natural, or archaeological significance.

2.4 Geology

A description of the major geological aspects of the site and its immediate environs should be provided. The level of detail presented should be appropriate to the proposed plant design and particularly the heat dissipation system planned. For example, if holding or cooling ponds are to be created, a detailed description of soil and bedrock types, etc. should be provided. Except for those specific features that are relevant to the environmental impact assessment, the discussion may be limited to noting the broad features and general characteristics of the site and environs (topography, stratigraphy, soil and rock types).

2.5 Hydrology

The effects of plant construction and operation on any adjacent above-ground or below-ground bodies of water are of prime importance. Accordingly, describe the physical, chemical, biological and hydrological characteristics (and their seasonal variations) of surface and ground waters (marshes, lakes, streams, estuaries, bays, oceans, etc.) of the site and the immediate environs. Only those waters that may affect plant effluents or that may be affected by the construction or operation of the proposed plant should be discussed. Where pollution exists, the applicant should estimate the extent and nature of the pollutants. Knowledge of the pollutant level will assist the applicant and the Commission in evaluating the effects of plant construction and operation under existing conditions of water quality and under conditions expected to exist as a result of the enforcement of national water pollution controls. Include a description of significant tributaries above and below the site and the pattern and gradients of drainage in the area. Note that information relating to water characteristics should include measurements, to the extent possible, made on or in close proximity to the site.

Relevant maxima, averages, and minima of important parameters of those ground and surface waters which may be affected by construction or operation of the plant or by upstream water users should be presented. These parameters include temperature, flow rate, velocity, water table altitude above mean sea level and chemical stratification, circulation patterns, river and lake levels, tides, floods, currents, wave action, and flushing times. These data should be provided out to 50 miles for streams or lakes and lake systems that may receive contaminated water from the plant. For lake systems that may receive contaminated water, the surface areas, flow rates (in and out) and volumes of the water bodies should also be provided. The manner in which volumes and areas change with expected seasonal and other level fluctuations should be included. Monthly values of these parameters should be presented as a minimum; daily values should be provided where they are important in determining environmental effects. Where a stream or other water body is to be used by the plant, the observed

7-day 10-year low flow value should be provided. Vertical and areal variations should be established on a regional basis as well as in the immediate vicinity of the site.

If data are available, ground water contours (including seasonal variations) within 2 or 3 miles of the plant should be presented. (Note that water use at the site is discussed in Section 2.2.)

In view of their importance in environmental impact assessment, the water quality standards or requirements applicable to any of the waters that may be affected by plant construction and operation should be cited. Relevant texts of the Federal, State and local laws, regulations or ordinances should be included as an appendix to the Report.

2.6 Meteorology[2]

Present data on site meteorology: (1) diurnal and monthly averages and extremes of temperature, dewpoint, and humidity; (2) monthly wind characteristics and all height(s) at which wind characteristics data are applicable or have been measured, including speeds, directions, frequencies and joint wind speed, stability category, wind direction frequencies; (3) data on precipitation; (4) frequency of occurrence and effects of storms accompanied by high velocity winds including tornadoes and hurricanes. (In the second item, the joint wind speed-stability-direction frequencies should be presented in tabular form, giving the frequencies as fractions when using 5-year U.S. Weather Bureau summaries, or as number of occurrences when using only one or two years of onsite data. The data should be presented for each of the 16 cardinal compass directions, and the stability categories should be established to conform as closely as possible with those of Pasquill.)

At the time of filing for a construction permit, the applicant may not have the detailed site meteorological data described above. In this case, the applicant may present information applicable to the general site area which is available from the U.S. Weather Bureau or other authoritative source.

2.7 Ecology

In this Section the applicant should identify the important flora and fauna in the region of the site (which may reasonably be expected to be affected by the proposed plant), their habitats and distribution as well as the relationship between species and their environments. A species, whether animal or plant, is "important" (1) if it is commercially or recreationally valuable, (2) if it is rare or endangered, or (3) if it affects the well-being of some important species within criteria (1) and (2) above, or (4) if it is critical to the structure and function of the ecological system. A "rare or endangered" species is any species officially designated as such by the U.S. Fish and Wildlife Service.

In cataloging the local organisms, the applicant should identify and discuss the abundance of the important terrestrial vertebrates and aquatic organisms. The discussion should include species that migrate through the area or use it for breeding grounds. The applicant should provide data on the count and distribution of important domestic fauna, in particular cows and goats, that may be involved in the radiological exposure of man via the iodine-milk route. A map that shows the distribution of the principal plant communities should be provided.

The discussion of species-environment relationships should include descriptions of area usage (e.g. habitat, breeding, etc.); it should include life histories of important regional animals and aquatic organisms, their normal seasonal population fluctuations and their habitat requirements (e.g. thermal tolerance ranges); and it should include identification of food chains and other interspecies relationships, particularly when these are contributory to predictions or evaluations of the impact of the nuclear plant on the regional biota.

Identify any definable pre-existing environmental stresses from sources such as pollutants, as well as any ecological conditions suggestive of such stresses. Describe the status of ecological succession. Discuss the histories of any infestations, epidemics, or catastrophes (caused by natural phenomena) that have had a significant impact on regional biota.

The sources of information should be identified. As part of this identification, present a list of any published material dealing with the ecology of the region. Locate and describe any ecological or biological studies of the site or its environs now in progress.

.8 Background radiological characteristics

Regional radiological data, including both natural background radiation levels and results of measurements of any concentrations of radioactive materials occurring in important biota, in soil and rocks and in regional surface and local ground waters should be reported. Of concern is the detection of radio-iodine in cows' milk; consequently, the regional radiological data base should include preoperational data from milk

[2] Safety Guide 23 "Onsite Meteorological Programs" (February 17, 1972) should be referred to for additional details.

sampling and analysis where other plants are in the vicinity. These data, whether determined during the applicant's preoperational surveillance program (see Section 6.1.5) or obtained from other sources, should be referenced.

2.9 Other environmental features

For certain sites, some relevant information on the plant environs may not clearly fall within the scope of the preceding topics. Additional information may be required with respect to some environmental features in order to reflect the value of the site and site environs to important segments of the population. Such information should be included here.

3. THE PLANT

The operating plant and transmission system are to be described in this Chapter. Since the environmental effects are of primary concern in the Report, the plant effluents and plant-related systems that interact with the environment should be described in particular detail.

3.1 External appearance

The building layout and plant perimeter should be illustrated and related to the site maps presented in Section 2.1. The plant profile should be shown to scale by line drawings or other illustrative techniques. A recent oblique aerial photograph should be included.

The architectural design and efforts to make the structures and grounds aesthetically pleasing should be noted.

The location and elevation of release points for liquid and gaseous wastes should be clearly indicated.

3.2 Reactor and steam-electric system

The reactor type (BWR, PWR, HTGR, etc.), manufacturer, architect-engineer, number of units, and kind (make) of turbine generator should be stated. The fuel (cladding, enrichment, etc.) should be described. Rated (license level) and design ("stretch" level) electrical and thermal power of the reactor as well as the in-plant electrical power consumption should be given.

3.3 Plant water use

A quantitative water-use diagram for the plant should be presented, showing water flows to and from the various plant water systems (heat dissipation system, sanitary system, radwaste and chemical waste systems, process water system, etc.) The sources of the water for each input should be described. Show total consumptive use of water by the plant. The above data which quantify plant water use should be tabulated for various plant conditions including maximum power operation, minimum anticipated power operation, temporary shutdown, with and without cooling towers and cooling ponds (if seasonal usage is planned). To avoid excessive detail on the diagram, cross-reference other sections (e.g., Sections 3.4, 3.5, 3.6, 3.7) for relevant data.

3.4 Heat dissipation system

Heat-removal facilities for normal operation should be discussed in detail. Simplified flow diagrams, sketches of intake and outfall structures should be presented. The reasons for providing the particular facilities (such as water resources limitations or reduction of thermal effects) should be noted. The source of the cooling water should be identified. (Its natural temperature, including monthly changes and stratification, should be described in Section 2.5.)

Topics to be covered include: quantity of heat dissipated; quantity of water withdrawn, consumptive use, return, design, size, and location of cooling towers, cooling lakes or spray ponds; air, water flow rates, pertinent temperatures, estimates of quantity of drift and drizzle (and methods used in making estimates) for cooling towers; blowdown volume, rate of discharge and physical and chemical characteristics for towers and ponds; temperature changes, rate of changes and holdup times in cooling ponds; rate of evaporation of water from towers or ponds; information on dams or dikes where a cooling reservoir is created; design and location of water intake structures, including water depth, flow and velocity, screens; number and capacity of pumps at intake structure; temperature differences between withdrawn and returned water; time of travel across condenser and to end of contained discharge lines, canals, etc. for different months and flows; point of addition and flow rate of any diluent added to the cooling water stream; details of outfall design including discharge flow and velocity and the depth of the discharge structure in the receiving water. Descriptions should include operational modes of important subsystems.

Procedures and schedules for removal and disposal of blowdown, of slimes and algal growth in the system, and of trash collected at the intake structures, should be described. Data on relevant chemical constituents should be presented in Section 3.6.

3.5 Radwaste systems

Provide a detailed description of the radwaste systems including flow diagrams showing origin, treatment, and disposal of all solid, liquid, and

gaseous radioactive waste generated by the plant under consideration. List estimated quantities, volumes and flow rates from all sources, expected decontamination factors, holding times, and expected frequency and magnitude of variations within normal operating conditions. (Accident conditions are to be discussed under Chapter 7.)

Indicate which radwaste systems are used singly and which are used jointly with other units at the site, as applicable. List all radionuclides (and their half-lives) that will be discharged with each effluent stream and give the expected annual average release rates.[1] If the release rates are intermittent, give the maximum release rates and times involved. Supply all pertinent supporting information, including a description of assumptions and computational methods used. Identify the physical characteristics of all radioactive effluents–particulate, ionic, gaseous, etc.

State the concentrations of all liquid effluent radionuclides prior to mixing with receiving water body (e.g., stream, lake, estuary). These concentrations should take into account dilution by plant water bodies such as cooling ponds or canals which receive effluents prior to mixing with the receiving water body. Seasonal and operational variations in dilution water usage in radwaste effluents should be stated.

Describe the release points (high stacks or vents) from which airborne or gaseous radioactive materials are to be emitted, giving base and release elevations, inside diameter and shape. In cases where the height of the emitting point is less than 2.5 times that of surrounding buildings, supply relevant information on height, location, and shape of nearby buildings and structures. (Cross reference to Section 3.1 as appropriate). Provide data on effluent velocity, volume flow rate from the release point, and the temperature of the effluent gases if appreciably different from ambient.

3.6 Chemical and biocide wastes

The applicant should describe chemical additives (including corrosion inhibitors, chemical and biological antifouling agents), corrosion products, waste streams or discharges from chemical processing and water treatment that may enter the local environment as a result of plant operation. Maximum and average concentrations of chemicals and solids in any brines or cooling-system effluents should be given. Ground deposition of chemicals and solids entrained in spray fallout should be estimated and the methods and bases for the estimates stated.

The discussion should include description of procedures by which effluents will be treated, controlled and discharged, the expected nominal and maximum concentrations for each discharge and the quantities that will be discharged in a specified time. Seasonal and operational variations in discharges should be described. A flow diagram (which may also be combined with the liquid radwaste system) should be included.

3.7 Sanitary and other waste systems

The applicant should describe any other nonradioactive solid or liquid waste materials, such as sanitary and chemical laboratory wastes, laundry and decontamination solutions, that may be created during plant operation. The description should include estimates of the quantities of wastes to be disposed of, their pollutant concentrations, biochemical oxygen demand, and other relevant data. The manner in which they will be treated and controlled and procedures for disposal should also be described.

The applicant should describe any other gaseous effluents (i.e., from diesel engines, gas turbines, heating plants, incinerators) created during plant operation; estimate the frequency of release and describe how they will be treated before release to the environment; estimate the total quantity of SO_2, NO_X pollutants to be discharged annually.

3.8 Radioactive materials inventory

The transportation of radioactive materials may have environmental effects. In this Section the radioactive materials to be transported to and from the site should be described.

A description of the type of fresh fuel to be used and the quantity to be shipped to the site each year should be provided. The form of fuel, enrichment, cladding, total weight per shipment, and expected form of packaging and the estimated number of shipments per year should be discussed.

The applicant should estimate the weight of irradiated fuel to be shipped from the site per year, the number of shipments per year, the average and maximum burnup for each shipment, the cooling time required prior to each shipment, and the expected form of packaging to be used.

Estimates of the annual weight, volume and activity of radioactive waste materials (e.g., spent resins and air filters) to be shipped from the site should be provided. The applicant should categorize the

[1] The information requested here is commonly called the "source term." The applicant's attention is directed to the set of questions in Appendix 1 of this Guide. The responses to these constitute the basic data required in calculating the source term. The applicant should submit answers to the questions in the Environmental Report.

wastes according to whether they are liquid, solid or gaseous. Any processing that may be required before shipment, such as compacting or consolidating with vermiculite and cement, should be described.

1.9 Transmission facilities

The Environmental Report should contain sufficient information to permit evaluation of the environmental impact of transmission lines and related facilities that are to be constructed from the proposed nuclear installation to an interconnecting point or points on the existing high-voltage transmission system. For material useful in preparing this subsection, the applicant is advised to consult the Department of Interior/Department of Agriculture publication entitled "Environmental Criteria for Electric Transmission Systems" (U.S. Government Printing Office, 1971) and the Federal Power Commission publication "Electric Power Transmission and the Environment."

This portion of the Report should identify and discuss parameters of possible environmental significance, including radiated electrical and acoustic noise, induced or conducted ground currents and ozone production.

The applicant should supply contour maps and/or aerial photographs showing the proposed right-of-way and identifying any existing substation(s) or other point(s) at which the transmission line(s) will connect with the existing high-voltage transmission system. The lengths and widths of the proposed rights-of-way should be specified. Any access roads, maintenance roads and new facilities located on or near the right-of-way should be shown. The applicant should characterize the land types to be crossed by the transmission line and indicate whether the land adjacent to the right-of-way has residential, agricultural, industrial or recreational uses. Any area where construction of the transmission line(s) will require permanent clearing of trees and vegetation, changes in topography, or removal of manmade structures should also be indicated as well as areas where the transmission line(s) will be placed underground. Indicate whether the high-voltage transmission lines will cross railroad rights-of-way. Any beneficial uses planned for the right-of-way should be discussed. The degree to which the above-ground lines will be visible from frequently traveled public roads should be indicated.

Adequate descriptions of proposed line-related facilities, such as substations, should be included in the Report. This portion of the Report should provide sufficient information on the external appearance of the transmission structures to permit an assessment of their aesthetic impact.

4. ENVIRONMENTAL EFFECTS OF SITE PREPARATION, PLANT AND TRANSMISSION FACILITIES CONSTRUCTION

This Chapter of the applicant's Environmental Report should discuss the expected effects of site preparation and plant and transmission facilities construction. The effects should be presented in terms of their physical impact on the resources and populations described in Chapter 2. Effects which are primarily economic or social in character should be discussed in Chapter 8.

The preparation of the site and the construction of a nuclear power plant and related facilities will inevitably affect the environment; some of the effects will be adverse and some will be beneficial. Effects are considered adverse if environmental change or stress causes some biotic population or natural resource to be less safe, less healthy, less abundant, less productive, less aesthetically or culturally pleasing, as applicable; or if the change or stress reduces the diversity and variety of individual choice, the standard of living, or the extent of sharing of life's amenities; or if the change or stress tends to lower the quality of renewable resources or to impair the recycling of depletable resources. Effects are considered beneficial if they cause changes or stresses having consequences opposite to those just enumerated.

In the applicant's discussion of adverse environmental effects, it should be made clear which of these are considered unavoidable and subject to later amelioration and which are regarded as unavoidable and irreversible. Those effects which represent an irretrievable commitment of resources should receive detailed consideration in Section 4.3. (In the context of this discussion, "irretrievable commitment of resources" alludes to natural sources and means a permanent impairment of these, e.g., loss of wildlife habitat; destruction of nesting, breeding or nursing areas; interference with migratory routes; loss of valuable or aesthetically treasured natural areas; as well as expenditure of directly utilized resources.)

4.1 Site preparation and plant construction

The applicant should organize the discussion in terms of the effects of site preparation and plant construction on (a) land use and (b) water use. The applicant should consider consequences to both human and wildlife populations and indicate which are unavoidable, reversible, etc. according to the categorization set forth earlier in this Chapter.

In the land use discussion, describe how construction activities may disturb the existing terrain and wildlife habitats. Consider the effects of such activities as creating building material supply areas; building temporary or permanent roads, bridges, service lines; disposing of trash and chemical wastes (including oil), excavating and land filling. Provide information bearing on such questions as: How much land will be torn up? For how long? Will there be dust or smoke problems? What explosives will be used? Where and how often? Indicate proximity of human populations and identify undesirable impacts on their environment arising from noise, from inconvenience due to the movement of men, material, machines, including activities associated with any provision of housing, transportation, educational facilities for workers and their families. A schedule of the estimated work force to be involved in site preparation and plant construction should be presented. Describe any expected changes in accessibility of historical, cultural and archaeological sites and natural landmarks in the region.

Discuss measures designed to mitigate or reverse undesirable effects, such as erosion control, dust stabilization, landscape restoration, control of truck traffic, restoration of affected animal habitat.

The discussion should also include any effects of site preparation and plant construction activities whose consequences may be beneficial to the region, as, for example, the use of spoil to create playgrounds and/or recreational facilities.

The discussion of water use should describe the impact of site preparation and construction activities on regional water (lakes, streams, ground water, etc.). The overall plan for use (recreation, reservoir, etc.) of water bodies that may be affected by plant construction should be discussed. Activities that might affect water use include the construction of cofferdams, and/or storm sewers, dredging operations, placement of fill material in the water, and the creation of shoreside facilities involving bulkheads, piers, jetties, basins or other structures enabling ingress or egress from the plant by water. Examples of other pertinent activities are the construction of intake and discharge structures for cooling water or other purposes, straightening or deepening a water channel and operations affecting water levels (flooding, construction, dewatering effects on nearby ground water users,

etc. The applicant should describe the effects of these activities on navigation, fish and wildlife resources, water quality, water supply, aesthetics and so on as applicable.

Measures to mitigate undesirable effects, such as flood and pollution control, erosion control, installation of fish ladders or elevators and other procedures for habitat improvement should be described.

Where it is proposed to create a cooling water lake, describe the effects on the local ecology, including the loss of flora and local migration of fauna from the area the lake will occupy. In addition, the expected establishment and development of aquatic plant and animal life should be described. This discussion may reference any available data based on studies of similarly sited artificial lakes.

4.2 Transmission facilities construction

The effects of construction and installation of transmission line towers and facilities on the land and on the people, including those living in and those visiting or traveling through the adjacent area, should be discussed in this Section. (Refer to Section 3.9 for the basic information.)

The following topics may serve as guidelines for this discussion but the applicant should include additional material if it is relevant:

a) Any permanent changes that will be induced in the physical and biological processes of plant and wild life through the changes in the hydrology, topography or ground cover or through the use of growth retardants, chemicals, biocides, sprays, etc. during construction and installation of the transmission lines.
b) Total length of new lines through and in various categories of visually sensitive land (that is sensitive to presence of transmission lines and towers) such as natural shoreline, marshland, wildlife refuges, parks, national and state monuments, scenic areas, recreation areas, historic areas, national forests and/or heavily timbered areas, shelter belts, steep slopes, wilderness areas.
c) Number and length of new access and service roads required.
d) Erosion directly traceable to construction activities.
e) Loss of agricultural productivity on right-of-way.
f) Mitigative measures such as plans for protection of wildlife, for disposal of slash and unmerchantable timber, and for cleanup and restoration of area affected by clearing and construction activities.

Briefly discuss the effects of construction on any identified rare or endangered species (as defined in Section 2.7) and what action will be taken to mitigate any adverse effects.

4.3 Resources committed

Discuss any irreversible and irretrievable commitments of resources (loss of land, nonrecyclable building materials, destruction of biota, etc.) which are expected should site preparation and plant and transmission facilities construction proceed. Such losses should be evaluated in terms of their relative and long term net, as well as absolute, impacts. (See Section 5.8 of this Guide for more detailed consideration.)

5. ENVIRONMENTAL EFFECTS OF PLANT OPERATION

This Chapter should describe the interaction of the plant and transmission facilities (discussed in Chapter 3) and the environment (discussed in Chapter 2). To the extent possible, the applicant should avoid repeating the material presented in Chapters 2 and 3. Measures planned to reduce any undesirable effects of plant operation (including the transmission facilities) on the environment should be described in detail. In the discussion of environmental effects, as in Chapter 4, effects that are considered unavoidable but either inherently temporary or subject to later amelioration should be clearly distinguished from those regarded as unavoidable and irreversible. Those effects which represent an irretrievable commitment of resources should receive detailed consideration in Section 5.8.

The impacts of operation of the proposed facility should be, to the fullest extent practicable, quantified and systematically presented.[1] In the discussion of each impact, the applicant should make clear whether the supporting evidence is based on theoretical, laboratory, on-site, or field studies undertaken on this or on previous occasions. The source of each impact—the plant subsystem, waste effluent—and the population or resource affected should be made clear in each case. The impacts should be distinguished in terms of their effects on surface water bodies, groundwater, air, and land.

Finally, the applicant should discuss the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity. As used in this Guide, "short term" may be taken to refer to the operating life of the proposed facility and "long term" to refer to time periods extending beyond this life. The applicant should assess the action for cumulative and projected long-term effects from the point of view that each generation is trustee of the environment for each succeeding generation. This means considering, for example, the commitment of a water source to use as a cooling medium in terms of impairment of other actual or potential uses, and any other long-term effects to which the operation of this facility may contribute.

5.1 Effects of operation of heat dissipation system

Waste heat, dissipated by the system described in Section 3.4, alters the thermal conditions of the environment. Since the heat transfer is usually effected through the surface of a river, pond, lake, estuary or ocean or by the evaporation of water in a cooling tower, the hydrology of the environment (Section 2.5) and the aquatic ecology (Section 2.7) are of primary importance in determining what effects the released heat will have on the environment.

Describe the effect that the heated effluent will have on the temperature of the receiving body of water with respect to space and time. Describe changes in temperature caused by drawing water from one depth and discharging it at another. The predicted characteristics of the mixing zone and temperature changes in the receiving body of water as a whole should be covered. Include seasonal effects. Discuss any model studies and calculations that have been performed to determine these characteristics, giving references to reports that provide supporting details. Details of calculational methods used in predicting thermal plume configurations should be given in an appendix to the Report.

Describe the thermal standards or limitations applicable to the water source (including maximum permissible temperature, maximum permissible increase, mixing zones, and maximum rates of increase and decrease) and whether, and to what extent, these standards or limitations have been approved by the Administrator of the Environmental Protection Agency in accordance with the Federal Water Pollution Control Act, as amended. Indicate whether the discharge could affect the quality of the waters of any other State or States.

Describe the effects of released heat on marine and fresh-water life. Give basis for prediction of effects. In this discussion, appropriate references to the baseline ecological data presented in Section 2.7 should be made. Expected thermal effects should be related to the optimum and tolerance temperature ranges for important (as defined in Section 2.7) aquatic species and the food base which supports them. The evaluation should consider not only the mixing zone, but the entire regional aquatic habitat potentially affected by operation of the proposed plant.

Potential hazards of the cooling water intake and discharge structures (described in Section 3.4) to fish species and food base organisms should be

[1] Quantification of environmental costs is discussed in Chapter 10.

identified and steps planned to measure and minimize the hazards should be discussed. Diversion techniques should be discussed in light of information obtained from ecological studies on fish population, size, and habitats.

The effects of passage through the condenser on zooplankton, phytoplankton, meroplankton, and small nektonic forms such as immature fish and the resultant implications for the important species and functional groups should be discussed.

The applicant should discuss the potential biological effects of modifying the natural circulation of the water body, especially where water is withdrawn from one region or zone and discharged into another. This discussion should consider such factors as the alteration of the dissolved oxygen and nutrient content and distribution in the receiving water as well as the effects of scouring and suspended sediments.

Plant-induced changes in the temperature of the discharged water subsequent to environmental stabilization, can affect aquatic life in the receiving body. Accordingly, the applicant should discuss the possible effects of reactor shutdown (and other temporary related conditions) including the dependence of effects on the season in which shutdown occurs. An estimate of the number of scheduled and unscheduled shutdowns per year should be given. Refueling schedules should be indicated, particularly where temperature cycling in the receiving waters is likely to be large (e.g., refueling in winter). Describe procedures for reducing thermal shock to aquatic organisms during shutdown or refueling.

Discuss the expected effects, if any, of heat dissipation facilities such as cooling towers, lakes, spray ponds, or diffusers on the local environment and on agriculture, housing, highway safety, airports, or other installations with respect to meteorological phenomena, including fog or icing, cooling tower blowdown and drift, noise. If fog or icing may occur, the estimated hours per year, distances, directions, and transportation arteries (including navigable waters) potentially affected should be presented and measures to mitigate such effects should be discussed. Consider possible synergistic effects that might result from mixing of fog or drift with other effluents in the atmosphere. (Environmental effects of chemicals discharged from cooling tower blowdown and drift should be discussed in Section 5.4).

In addition to the meteorological effects noted, other local environmental impacts may occur. These should be described. For example, where a cooling pond or lake has been created, the effects on ground water may be substantial; consequently, the alteration of water table levels, recharge rates, soil permeability should be discussed.

5.2 Radiological impact on biota other than man

In this Section the applicant should consider the impact on biota other than man attributable to the release of radioactive materials from the facility. The biota to be considered are those species of local flora and local and migratory fauna defined as "important" in Section 2.7. Since the region may contain many important species, the applicant need consider only those important species whose terrestrial and/or aquatic habitats provide the highest potential for radiation exposure.

5.2.1 Exposure pathways

The various possible pathways for radiation exposure of the important local flora and local and migratory fauna should be identified and described in textual and flowchart format. (An example of an exposure pathway chart is given in Appendix 2.) The pathways should include the important routes of radionuclide translocation (including food chains leading to important species) to organisms or sites.

5.2.2 Radioactivity in environment

In Section 3.5, the radionuclide concentrations in the liquid and gaseous effluents from the facility are listed. In this Section, the applicant should consider how these effluents are quantitatively distributed in the environment. Specifically, estimates should be provided for the radionuclide concentrations in all waters that receive any liquid radioactive effluent, on land areas, and on vegetation (on a per unit area basis) in the environs.

If there are other components of the physical environment that may become contaminated and thus cause the exposure of living organisms to nuclear radiations, they should be identified and their radioactivity burden estimated. In addition, information concerning any cumulative buildup of radionuclides in the environment, such as in sediments, should be presented and discussed.

A summary of data, assumptions and models used in determining radioactivity concentrations and burdens should be provided.

5.2.3 Dose rate estimates

From considerations of the exposure pathways and the distribution of

facility-derived radioactivity in the environs, the applicant should estimate the maximum radionuclide concentrations that may be on the ground surface and present in important local flora and local and migratory fauna and the dose rates (rad/year) that may result from those concentrations. Values of bioaccumulation factors[2] used in preparing the estimates should be based on site-specific data if available; otherwise, values from the literature may be used. The applicant should tabulate and reference the values of bioaccumulation factors used in the calculations.

Dose rates to important local flora and local and migratory fauna that receive the highest exposures, should be provided.

5.3 Radiological impact on man

In this Section the applicant should consider the radiological effects of facility operation and transportation of radioactive materials on man. Estimates of the radiological impact on man via various exposure pathways should be provided.

5.3.1 Exposure pathways

The various possible pathways for radiation exposure of man should be identified and described in textual and flowchart format. (An example of an exposure pathway chart is given in Appendix 2.) As a minimum, the following pathways should be evaluated: drinking (milk and water); swimming; fishing; eating fish and game, invertebrates, and plants.

5.3.2 Liquid effluents

Estimate the expected annual average concentrations of radioactive nuclides (listed in Section 3.5) in receiving water at locations where water is consumed or otherwise used by human beings or where it is inhabited by biota of significance to human food chains. (If discharges are intermittent, concentration peaks as well as annual averages should be estimated.) Specify the dilution factors used in preparing the estimates and the locations where the dilution factors are applicable. Note that, for radioactive effluents mixed with the thermal discharge, the dilution and distribution of radionuclides in the receiving water body will be influenced by the dynamics and configuration of the thermal plume.

Provide data on recreational and similar use of receiving water and its shoreline, e.g., swimming, fishing, picnicking, hunting, clam digging. Include any persons who spend the major part of their working time on the water adjacent to the site and indicate the amount of time spent per year in this activity.

Data on irrigation usage of the receiving water should be included, such as the number of acres irrigated, points at which irrigation water is drawn (downstream from the site), what type(s) of crops are produced within 50 miles of the site and the yield of each crop per acre.

Provide data on the commercial and recreational fish and seafood catch (number of pounds per year of each species within the region). Include any harvest and usage of seaweed or other aquatic plant life.

Determine the expected radionuclide concentrations in aquatic and terrestrial organisms significant to human food chains. Use the bioaccumulation factors given in Section 5.2.3 or supply others as necessary. If significant hunting occurs on land adjacent to or near the site of the nuclear plant and the flesh is eaten by the local populace, annual weight and radionuclide concentrations should be estimated.

Calculate the following, using the above information and any other necessary supporting data (provide details and models of the calculation as an appendix):

Total body and significant organ (including GI tract, thyroid, skin and bone) doses (rem/year) to individuals in the population from all receiving water-related exposure pathways, i.e., all sources of internal and external exposure.

5.3.3 Gaseous effluents

From release rates of radioactive gases and particulates and meteorological data (Sections 3.5 and 2.6, respectively), estimate total body and significant organ doses (rem/year) to individuals exposed at the point of maximum

[2] The bioaccumulation factor is the equilibrium ratio: (concentration in organism)/(concentration in water). Values of bioaccumulation factors can be obtained from such references as:

S. E. Thompson, C. A. Burton, D. J. Quinn, Y. C. Ng, "Concentration Factors of Chemical Elements in Edible Aqueous Organisms", University of California, Lawrence Livermore Laboratory report UCRL-50564 (Rev. 1), October 1972. (Revision of identically titled document, dated December 30, 1968, by W. H. Chapman, H. L. Fisher, M. W. Pratt.)

A. M. Freke, "A Model for the Approximate Calculation of Safe Rates of Discharge of Radioactive Wastes Into Marine Environments" *Health Physics, 13*, 734 (1967).

ground-level concentrations off-site. Assume meterological conditions during releases which are consistent with expected periods of release. For example, assume annual average meteorological conditions for a BWR and limiting meteorological conditions for a PWR. Identify locations of points of release (stack, roof vent, etc.) used in calculations.

Estimate deposition of radioactive halogens and particulates on food crops and pasture grass. Consider maximum ground-level deposition on pasture grass, even though milk cows or goats may not be grazing there at the present time. Estimate total body and thyroid doses (rem/year) and significant doses received by other organs via such potential pathways.

Provide an appendix describing the models used in these calculations.

5.3.4 Direct radiation

5.3.4.1 Radiation from facility

The applicant should provide an estimate of the total external dose (rem/year) and the total population external dose (man-rem/year) received by individuals outside the facility from direct radiation, e.g., gamma radiation emitted by turbines and radioactive waste vessels. In particular, the applicant should estimate the expected external dose rates received by individuals in nearby residences and schools, hospitals, or other publicly used facilities. A summary of data, assumptions and models used in the dose calculations should be given.

5.3.4.2 Transportation of radioactive materials

Radioactive materials to be shipped to and from the plant during its operation have been identified and described in Section 3.8.

The applicant should identify the supplier of the fresh fuel and the most likely route to be taken by the carrier from the point of supply to the plant. The distance, most likely mode of transport and details of shipment should be described. The latter discussion should include information on the number of fuel elements per package, number of packages per vehicle (truck, barge, railroad car) and the probable number of shipments per year.

Similar information concerning shipments of irradiated fuel should be supplied by the applicant. In connection with the description of shipment details, the applicant should indicate the method of in-transit cooling and the methods used to contain leaking fuel assemblies.

For other radioactive wastes to be shipped from the plant, the applicant should identify the disposal site and its distance from the plant, the most likely route of transport, mode of transport as well as the type of packaging, the number, weight and activities of packages to be shipped each year.

The information supplied by the applicant will be used by the Commission to estimate (per trip and per year) the radiological dosages, if any, to drivers, helpers and population along the transport route for fresh fuel, irradiated fuel, and radioactive wastes.[3]

5.3.5 Summary of annual radiation doses

The applicant should present a table that summarizes the estimated radiation dose to the regional population (at startup of the facility) from all plant-related sources using values calculated in previous Sections. The tabulation should include (a) the total of the whole-body doses to the population (man-rem/year) from all receiving water-related pathways and (b) the total of the whole-body doses to the population (man-rem/year) attributable to gaseous effluents out to a distance at least of 50 miles from the site.

5.4 Effects of chemical and biocide discharges

Chemical and biocide discharges have been described in Section 3.6. Water resources and use are discussed in Sections 2.5 and 3.3. In this Section, the specific concentrations of these wastes at the points of discharge should be compared with natural ambient concentrations without the discharge and also compared with applicable water standards. The projected effects of the effluents for both acute and chronic exposure of the biota (including any long-term buildup in sediments and in the biota) should be identified and discussed. Dilution and mixing of discharges into the receiving

[3] A general analysis of the environmental impact of transporting radioactive materials to and from a light-water nuclear power reactor has recently been issued by the Commission. See "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants", USAEC, Directorate of Regulatory Standards, December 1972, and 38 F.R. 3334 (Feb. 5, 1973).

waters should be discussed in detail and estimates of concentrations at various distances from the point of discharge should be provided. Include a detailed description of the method of calculation. The estimated area in the receiving body of water enclosed by contours corresponding to water-quality-standard values should be given. Variation of concentrations with changes in condition (e.g. stream flow, temperature) of receiving water should be discussed. The effects on terrestrial and aquatic environments from oil or chemical wastes which contaminate surface and/or ground water should be included.

The effects of chemicals in cooling tower blowdown and drift on the environment should also be considered in this Section. Estimates of concentrations at various distances should be provided. Include a description of the method of calculation.

Any anticipated chemical or biocide contamination of domestic water supplies (from surface water bodies or ground water) should be identified and discussed. Rate of percolation of each contaminant into the water supply and the resulting concentration in the water should be estimated.

5.5 Effects of sanitary and other waste discharges

Sanitary and other waste systems have been described in Section 3.7. The expected discharges should be discussed as in Section 5.4.

5.6 Effects of operation and maintenance of the transmission system

The environmental effects of operation and maintenance of the transmission system required to tie in the proposed facility to the pre-existing network should be evaluated. The evaluation of effects should make clear the applicant's plans for maintenance of the right-of-way and required access roads. Plans for use of herbicides and pesticides should indicate types, volume, concentrations, and manner and frequency of use. Resulting effects on plant life, wildlife habitat, land resources, and scenic values should be evaluated.

New access roads may increase the exposure of transmission corridors to the public. The applicant should consider the potential effect of this increased exposure on resident wildlife.

This Section of the Report should also reference the applicant's estimate of any electrical effects of potential environmental significance which were previously identified and discussed in Section 3.9.

5.7 Other effects

The applicant should discuss any effects of plant operation that do not clearly fall under any single topic of Sections 5.1 to 5.6. These may include changes in land and water use at the plant site, interaction of the plant with other existing or projected neighboring plants, effect of ground water withdrawal on ground water resources in the vicinity of the plant and disposal of solid and liquid wastes other than those discussed in Sections 5.3 through 5.5.

5.8 Resources committed

Any irreversible and irretrievable commitments of resources due to plant operation should be discussed. This discussion should include both direct commitments, such as depletion of uranium resources, and irreversible environmental losses, such as destruction of wildlife habitat.

In this discussion the applicant should consider lost resources from the viewpoints of both relative impacts and long-term net effects. As an example of relative impact assessment, the loss of two thousand fish of a given species could represent quite different degrees of significance, depending on the total population in the immediate region. Such a loss, however, in the case of a small local population, could be less serious if the same species were abundant in neighboring regions. Similarly, the loss of a given area of highly desirable land should be evaluated in terms of the total amount of such land in the environs. These relative assessments should accordingly include statements expressed in percentage terms in which the amount of expected resource loss is related to the total resource in the immediate region and in which the total in the immediate region is related to that in surrounding regions. The latter should be specified in terms of areas and distances from the site.

In evaluating long-term effects for their net consequences, the applicant may consider, as an example, the impact of thermal and chemical discharges on fish. There may be severe losses in the local discharge area. The local population change may or may not be a net loss. Therefore, changes in population of important species, caused by, or expected to be caused by, the operation of the plant should be examined with the view of determining whether they represent long-term net losses or long-term net gains. The considerations are also applicable to Chapters 9 and 10 of the Report.

5.9 Decommissioning and dismantling

The applicant should describe its plans and policies regarding the actions to be taken at the end of the plant's useful life. Information should be provided on the long-term uses of the land, the amount of land irretrievably committed, the expected environmental consequences of decommissioning, and an estimate of the monetary costs involved.

The applicant should also discuss the consideration given in the design of the plant and its auxiliary systems relative to eventual decommissioning, the amount of equipment and buildings to be removed, and the expected condition of the site after decommissioning. It is understood that the plans and intentions of applicants for a Construction Permit may not be fully developed at the time of filing. However, since the environmental impact of terminating plant operation is, in part, determined by plant design, applicants should give attention to the subject early in the project planning.

6. EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

The intent of the Chapter is to describe in detail the means by which the applicant collected the baseline data presented in other Chapters and to describe the applicant's plans and programs for monitoring the environmental impacts of site preparation, plant construction and operation.

Section 6.1 is addressed to the measurement of characteristics of the site and the surrounding region before site preparation or construction activities have started. This program should have established, at least in part, a reference framework for assessing subsequent environmental effects attributable to the activity. The applicant's attention is directed to two considerations pertinent to Section 6.1. First, a given characteristic or parameter may or may not require assessment prior to site preparation and plant construction, depending on whether that particular characteristic may be altered at these stages. Second, in most instances this Guide indicates the specific environmental effects to be evaluated; consequently, the parameters to be measured will be apparent. In some cases, the applicant may consider it necessary to establish a monitoring program based on identification of potential or possible effects not mentioned in the Guide. In such instances, the program should be described. The applicant should carefully review the plans for measurement of conditions existing prior to site preparation to ensure that these plans include all parameters which must be subsequently monitored during plant operation (discussed in Section 6.2) as well as during site preparation and plant construction.

Sampling design, frequency, methodology (including calibration and checks with standards) and instrumentation for both collection and analysis should be discussed as applicable. Information should be provided on instrument accuracy, sensitivity and, especially for highly automated systems, reliability. Where standard analytical or other techniques are used, they need only be identified and referenced.

6.1 Applicant's pre-operational environmental programs

The programs for collection of initial or baseline environmental data prior to operation should be described in sufficient detail to make it clear that the applicant has established a thorough and comprehensive approach to environmental assessment. The description of these programs should be confined principally to technical descriptions of technique, instrumentation, scheduling and procedures.

Where an effect of site preparation and/or facility construction may alter a previously measured or observed environmental condition, the program for determining the modified condition should be described.

Where information from the literature has been used by the applicant, it should be concisely summarized and documented by reference to original data sources. Where the availability of original sources that support important conclusions is limited, the applicant should provide either extensive quotations or references to accessible secondary sources.[1] In all cases, information derived from published results should be clearly distinguished from information derived from the applicant's field measurements.

6.1.1 Surface waters

When a body of surface water may be affected by the proposed facility or a practicable alternative, the applicant should describe the programs by which the background condition of the water and the related ecology were determined and reported in Section 2.5.

6.1.1.1 Physical and chemical parameters

The programs and methods for measuring physical and chemical parameters of surface waters which may be affected by construction and/or operation of the facility should be described. The sampling program should be presented in sufficient detail to demonstrate its adequacy with respect both to spatial coverage (surface area and depth) and to temporal coverage (duration and sampling frequency), giving due consideration to seasonal effects. This discussion should include a description of

[1] Any reports of work (e.g., ecological surveys) supported by the applicant that are of significant value in assessing the environmental impact of the facility may be included as appendices or supplements to the Environmental Report, if these reports are not otherwise generally available.

the techniques used to investigate any condition that might lead to interactions with plant discharges, such as how the presence of impurities in a water body may react synergistically with heated effluent or how the heated effluent may restrict mixing and dispersion of radioactive effluents.

In addition to describing the programs for obtaining the data, the applicant should also describe any computational models used in predicting effects. The applicant should indicate how the models were verified and calibrated.

6.1.1.2 Ecological parameters

The applicant should describe the preoperational program used to determine the ecological characteristics presented in Section 2.7. Those portions of the program concerned with determining the presence and abundance of important aquatic and amphibious species (identified in Section 2.7) should be detailed in terms of frequency, pattern and duration of observation. The applicant should describe how taxonomic determinations were made and validated. In this connection, the applicant should discuss its reference collection of voucher specimens or other means whereby consistent identification will be assured.

A description should be provided of the methods used or to be used for observing natural variations of ecological parameters. If these methods will involve indicator organisms, the criteria for their selection should be presented.

The applicant should discuss the basis for its predictions of any non-lethal physiological and behavioral responses of important species which may be caused by construction and/or operation of the facility. This discussion should be appropriately correlated with the description of the monitoring program.

Sources of parameters of lethality for organisms potentially affected by plant discharges should be identified. The methodology for determining such parameters should be reviewed with respect to applicability to actual local conditions to be anticipated during operation, including interactive effects among multiple effluents and existing constituents of the surface water body concerned.

6.1.2 Ground water

In those cases in which the proposed facility or a practicable design alternative mr potentially affect local ground water, ti program leading to assessment of potential effects should be described.

6.1.2.1 Physical and chemical parameters

The properties and configuration of the local aquifer should have been defined in sufficient detail (in Section 2.5) to permit a reasonable projection of effects of plant operation on the ground water. Methods for obtaining information on ground water levels and ground water quality should be described.

6.1.2.2 Models

Models may be used to predict effects, such as changes in ground water levels, dispersion of contaminants, and eventual transport through aquifers to surface water bodies. The models should be described and supporting evidence for their reliability and validity presented.

6.1.3 Air

The applicant should describe the program for obtaining information on local air quality, relevant, and local meteorology. The description should show the basis for predicting such effects as the dispersion of gaseous effluents and alteration of local climate (e.g., fogging and icing) as well as present the methodology for gathering baseline data.

6.1.3.1 Meteorology

The applicant should identify sources of meteorological data reported in Section 2.6. Locations and elevations observation stations, instrumentation, and frequency and duration of measurements should be specified both for the applicant's measuring activities and for activities of governmental agencies or other organizations on whose information the applicant intends to rely.

6.1.3.2 Models

Any models used by the applicant either to derive estimates of basic meteorological information or to estimate the effects of effluent systems should be described and their validity and accuracy discussed.

6.1.4 Land

Data collection and evaluation programs concerning the terrestrial environment of the proposed facility should be described and justified with regard to both scope and methodology.

6.1.4.1 Geology and soils

Those geological and soil studies designed to determine the environmental impact of the construction and/or operation of the facility should be described. The description should include identification of the sampling pattern and the justification for its selection, the sampling method, pre-analysis treatment, and analytic techniques. Other geological and soil studies (e.g. conducted in support of safety analyses) should be briefly summarized if relevant.

6.1.4.2 Land use and demographic surveys

The applicant should describe its program for identifying the actual land use in the site environs and for acquiring demographic data for the region as reported in Section 2.2

Sources of information should be identified. Methods used to forecast probable changes in land use and demographic trends should be described.

6.1.4.3 Ecological parameters

In this Section the applicant should discuss the program used to assess the ecological characteristics of the site with primary reference to important terrestrial biota identified in Section 2.7. In general, the considerations involved are similar to those suggested in connection with aquatic biota (Section 6.1.1.2). However, the difference in habitat, differences in animal physiology and other pertinent factors will, of necessity, influence the design of the assessment program. The applicant should present, as in Section 6.1.1.2, an analysis of the program in terms of taxonomic validation, rationale for its predictive aspects and the details of its methodology.

6.1.5 Radiological surveys[2]

This Section of the Environmental Report the pre-operational radiation levels at the site and environs and the concentrations of any radioactive materials occurring in important local and regional biota, as well as in soil, rocks and surface waters (see Section 2.8).

The methods used should be thoroughly described and documented. The discussion should include rationale for the choice of sampling and collection sites, identification of sampling and collection sites, sampling methods, duration and frequency, and analytical procedures (including pre-analysis treatment, instrumentation and minimum sensitivities) as applicable.

Radiological surveys conducted prior to the time of application for a construction permit may be limited. Since the radiation levels at the site and environs are not likely to be affected by site preparation and plant construction, the applicant may chose to defer full development of the radiological monitoring program. In this case, the applicant should provide the information on pre-operational radiological surveys in the "Environmental Report–Operating License Stage".

6.2 Applicant's proposed operational monitoring programs

The applicant should present the proposed operational monitoring program for the facility. Review of this description will be facilitated if the applicant includes maps of observation sites and tabular presentation of summary descriptors of such factors as frequency, type of sampling, method of collection, analytic method, holding times and pre-analysis treatment, instrumentation, and minimum sensitivities.

Certain aspects of the proposed operational monitoring programs may not be fully developed at the time of applying for a construction permit. The applicant should describe the programs in as much detail as possible at the construction permit stage and indicate what information will be supplied later (at the time of application for an operating license).

6.2.1 Radiological monitoring[3, 4]

The applicant's program for monitoring radiological effects during operation should be

[2] Information on radiological surveys submitted by the applicant in its Safety Analysis Reports may be incorporated in this Section as appropriate.

[3] Information on radiological surveys and monitoring submitted by the applicant in its Safety Analysis Reports may be incorporated in this Section as appropriate. The applicant may also wish to refer to recognized handbooks on radiological surveys such as the "Environmental Radioactivity Surveillance Guide", Environmental Protection Agency Technical Report ORP/SID 72-2 (June 1972).

[4] See also USAEC Regulatory Guide 4.1.

described both for the plant effluent monitoring systems and the environmental monitoring program.

6.2.1.1 Plant effluent monitoring system

The applicant should describe, in general, systems for monitoring radioactive liquid and gaseous effluents. The sensitivity limits for detecting radioactivity corresponding to routinely expected release rates should be discussed. A list of the effluent streams, if any, that will not be monitored and a brief rationale for the absence of monitoring should be provided.

6.2.1.2 Environmental radiological monitoring

The operational surveillance program should be described in detail, with specific attention given to the types of samples to be collected, sampling locations and frequency, and the analyses to be performed on each sample. The analytical sensitivity (detection threshold) for each analysis and the schedule for reporting data collected from the surveillance program should be discussed. Rationale for the choice of sampling locations, frequency, and types of samples to be collected should be presented.

6.2.2 Chemical effluent monitoring

The proposed measurement program, including instrumentation, sampling locations and frequencies, and analytical techniques, should be fully described. The description of the program should include instrumentation sensitivity and, particularly in the case of automated systems, reliability. Monitoring procedures prescribed by local, State, or Federal agencies as conditions placed upon operation should be so identified.

If the program for monitoring chemical effluents does not include monitoring substances which are already present in the intake water and which are routinely discharged from the facility, the bases for these omissions should be explained.

6.2.3 Thermal effluent monitoring

The proposed program for monitoring thermal effluents should be described and sampling sites located on maps or diagrams. Sampling procedures, schedules, and instrumentation sensitivity and reliability should be described.

6.2.4 Meteorological monitoring

The applicant's program for monitoring meteorological phenomena should be described including rationale for choice of location and height(s). In cases where possible fogging and icing in the environs are predicted, the quantitative levels of the phenomena to be observed should be specified. The applicant should describe plans for compiling data and verifying models. Means by which the meteorological effects of plant operation can be isolated from natural meteorological phenomena should be described. (This may include correlation of data with observations made at a site nearby, but out of range of significant effects originating within the site.)

6.2.5 Ecological monitoring

In the pre-operational surveillance program the applicant will have established methodology for determining the ecological characteristics of the region. In principle, this methodology should be appropriate for the subsequent monitoring program to be maintained during plant operation. However, the applicant may choose to modify some aspects of his methodology in view of the requirement for protracted monitoring. Such aspects, may include frequency, observation sites and so forth. These should be described and justified. Also, the applicant should, in this Section, indicate how changes in the physiological and behavioral characteristics of the observed biota will be ascribed either to specific effects of plant operation or to natural variation or to other causes, to the extent feasible.

6.3 Related environmental measurement and monitoring programs

When the applicant's site lies within a region for which environmental measurement and/or monitoring programs are carried out by public or other agencies not directly supported by the applicant, any such related programs known to the applicant should be identified and discussed. Relevance of such independent findings to the proposed facility's effects should be described and plans for exchange of information, if any, should be presented. Agencies responsible for the programs should be identified and, to the extent possible, the procedures and methodologies employed should be briefly described.

7. ENVIRONMENTAL EFFECTS OF ACCIDENTS

In this Chapter the applicant should discuss the potential environmental effects of accidents within the plant.

7.1 Plant accidents involving radioactivity

Postulated accidents are discussed in another context in applicant's safety analysis reports. The principal line of defense is accident prevention through correct design, manufacture, and operation, and a quality assurance program is used to provide and maintain the necessary high integrity of the reactor system. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding all this, the conservative postulate is made that serious accidents might occur, in spite of the fact that they are extremely unlikely, and engineered safety features are installed to mitigate the consequences of these unlikely postulated events.

In the consideration of the environmental risks associated with the postulated accidents, the probabilities of their occurrence and their consequences must both be taken into account. Since it is not practicable to consider all possible accidents, the spectrum of accidents, ranging in severity from trivial to very serious, is divided into classes.

Each class can be characterized by an occurrence rate and a set of consequences.

Standardized examples of classes of accidents to be considered by applicants in preparing the section of Environmental Reports dealing with accidents are set out in tabular form below. The spectrum of accidents, from the most trivial to the most severe, is divided into nine classes, some of which have subclasses. The accidents stated in each of the eight classes in tabular form below are representative of the types of accidents that must be analyzed by the applicant in Environmental Reports; however, other accident assumptions may be more suitable for individual cases. Where assumptions are not specified, or where those specified are deemed unsuitable, assumptions as realistic as the state of knowledge permits shall be used, taking into account the specific design and operational characteristics of the plant under consideration.

For each class, except Classes 1 and 9, the environmental consequences shall be evaluated as indicated. Those classes of accidents, other than Classes 1 and 9, found to have significant adverse environmental effects shall be evaluated as to probability, or frequency of occurrence, to permit estimates to be made of environmental risk or cost arising from accidents of the given class.

Class 1 events need not be considered because of their trivial consequences.

Class 8 events are those considered in safety analysis reports and AEC staff safety evaluations. They are used, together with highly conservative assumptions, as the design-basis events to establish the performance requirements of engineered safety features. The highly conservative assumptions and calculations used in AEC safety evaluations are not suitable for environmental risk evaluation, because their use would result in a substantial overestimate of the environmental risk. For this reason, Class 8 events shall be evaluated realistically. Consequences predicted in this way will be far less severe than those given for the same events in safety analysis reports where more conservative evaluations are used.

The occurrences in Class 9 involve sequences of postulated successive failures more severe than those postulated for establishing the design basis for protective systems and engineered safety features and for site evaluation purposes. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture, and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficiently remote in probability that the environmental risk is extremely low. For these reasons, it is not necessary to discuss such events in the Environmental Report.

Furthermore, it is not necessary to take into account those Class 8 accidents for which the applicant can demonstrate that the probability has been reduced and thereby the calculated risk to the environment made equivalent to that which might be hypothesized for a Class 9 event.

The applicant may substitute other accident class breakdowns and alternative values of radioactive material releases and analytical assumptions, if such substitution is justified in the Environmental Report.

ACCIDENT ASSUMPTIONS

ACCIDENT–1.0 Trivial Incidents

These incidents shall be included and evaluated under routine releases in accordance with proposed Appendix I of 10 CFR Part 50.

ACCIDENT–2.0 Small Release Outside Containment

These releases shall include such things as releases through steamline relief valves and small spills and leaks of radioactive materials outside containment. These releases shall be included and evaluated under routine releases in accordance with proposed Appendix I of 10 CFR Part 50.

ACCIDENT–3.0 Radwaste System Failure

3.1 Equipment leakage or malfunction (Includes operator error)

(a) Radioactive gases and liquids: 25% of average inventory in the largest storage tank shall be assumed to be released.

(b) Meteorology assumptions: χ/Q shall be determined from onsite meteorological data at the 50% probability level.[1]

(c) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

3.2 Release of waste gas storage tank contents (Includes failure of release valve and rupture disks)

(a) 100% of the average tank inventory shall be assumed to be released.

(b) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(c) Consequences should be calculated by weighting the effects in different directions by the frequency of the wind blows in each direction.

3.3 Release of liquid waste storage tank contents

(a) Radioactive liquids: 100% of the average storage tank inventory shall be assumed to be spilled on the floor of the building.

(b) Building structure shall be assumed to remain intact.

(c) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(d) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

ACCIDENT–4.0 Fission Products to Primary System (BWR)

4.1 Fuel cladding defects

Release from these events shall be included and evaluated under routine releases in accordance with proposed Appendix I of 10 CFR Part 50.

4.2 Off-design transients that induce fuel failures above those expected (Such as flow blockage and flux maldistributions)

(a) 0.02% of the core inventory of noble gases and 0.02% of the core inventory of halogens shall be assumed to be released into the reactor coolant.

(b) 1% of the halogens in the reactor coolant shall be assumed to be released into the steam.

(c) The mechanical vacuum pump shall be assumed to be automatically isolated by a high radiation signal on the steam line.

(d) Radioactivity shall be assumed to carry over to the condenser where 10% of the halogens shall be assumed to be available for leakage from the condenser to the environment at 0.5%/day for the course of the accident (24 hours).

(e) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

ACCIDENT–5.0 Fission Products to Primary and Secondary Systems (Pressurized Water Reactor)

5.1 Fuel cladding defects and steam generator leak

Release from these events shall be included and evaluated under routine releases in accordance with proposed Appendix I of 10 CFR Part 50.

5.2 Off-design transients that induce fuel failure above those expected and steam generator leak (such as flow blockage and flux maldistributions)

(a) 0.02% of the core inventory of noble gases and 0.02% of the core inventory

[1] See AEC Safety Guide 23, "Onsite Meteorological Programs" (Feb. 17, 1972).

and halogens shall be assumed to be released into the reactor coolant.

(b) Average inventory in the primary system prior to the transient shall be based on operation with 0.5% failed fuel.

(c) Secondary system equilibrium radioactivity prior to the transient shall be based on a 20 gal/day steam generator leak and a 10 gpm blowdown rate.

(d) All noble gases and 0.1% of the halogens in the steam reaching the condenser shall be assumed to be released by the condenser air ejector.

(e) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

5.3 Steam generator tube rupture

(a) 15% of the average inventory of noble gases and halogens in the primary coolant shall be assumed to be released into the secondary coolant. The average primary coolant activity shall be based on 0.5% failed fuel.

(b) Equilibrium radioactivity prior to rupture shall be based on a 20 gallon per day steam generator leak and a 10 gpm blowdown rate.

(c) All noble gases and 0.1% of the halogens in the steam reaching the condenser shall be assumed to be released by the condenser air ejector.

(d) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(e) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

ACCIDENT–6.0 Refueling Accidents

6.1 Fuel bundle drop

(a) The gap activity (noble gases and halogens) in one row of fuel pins shall be assumed to be released into the water. (Gap activity is 1% of total activity in a pin).

(b) One week decay time before the accident occurs shall be assumed.

(c) Iodine decontamination factor in water shall be 500.

(d) Charcoal filter efficiency for iodines shall be 99%.

(e) A realistic fraction of the containment volume shall be assumed to leak to the atmosphere prior to isolating the containment.

(f) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(g) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

6.2 Heavy object drop onto fuel in core

(a) The gap activity (noble gases and halogens) in one average fuel assembly shall be assumed to be released into the water. (Gap activity shall be 1% of total activity in a pin).

(b) 100 hours of decay time before object is dropped shall be assumed.

(c) Iodine decontamination factor in water shall be 500.

(d) Charcoal filter efficiency for iodines shall be 99%

(e) A realistic fraction of the containment volume shall be assumed to leak to the atmosphere prior to isolating the containment.

(f) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(g) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

ACCIDENT–7.0 Spent Fuel Handling Accident

7.1 Fuel assembly drop in fuel storage pool

(a) The gap activity (noble gases and halogens) in one row of fuel pins shall be assumed to be released into the water. (Gap activity shall be 1% of total activity in a pin).

(b) One week decay time before accident occurs shall be assumed.

(c) Iodine decontamination factor in water shall be 500.

(d) Charcoal filter efficiency for iodines shall be 99%.

(e) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

7.2 Heavy object drop onto fuel rack

(a) The gap activity (noble gases and halogens) in one average fuel assembly

shall be assumed to be released into th water. (Gap activity is 1% of tota activity in a pin).

(b) 30 days decay time before the acciden occurs shall be assumed.

(c) Iodine decontamination factor in wate shall be 500.

(d) Charcoal filter efficiency for iodines shal be 99%.

(e) Meteorology assumptions: χ/Q value shall be determined from onsit meteorological data at the 50% probability level.

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Fuel cask drop

(a) Noble gas gap activity from one fully loaded fuel cask (120 day cooling) shall be assumed to be released. (Gap activity shall be 1% of total activity in the pins).

ACCIDENT–8.0 Accident Initiation Events Considered in Design Basis Evaluation in the Safety Analysis Report

8.1 Loss-of-coolant accidents

Small Pipe Break (6-in. or less)

(a) Source term: the average radioactivity inventory in the primary coolant shall be assumed. (This inventory shall be based on operation with 0.5% failed fuel).

(b) Filter efficiencies shall be 95% for internal filters and 99% for external filters.

(c) 50% building mixing for boiling water reactors shall be assumed.

(d) For the effects of plateout, sprays, decontamination factor in pool, and core sprays the following reduction factors shall be assumed:

For pressurized water reactors: 0.05 with chemical additives in sprays, 0.2 for no chemical additives.

For boiling water reactors: 0.2.

(e) A realistic building leak rate as a function of time shall be assumed.

(f) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(g) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large Pipe Break

(a) Source term: The average radioactivity inventory in the primary coolant shall be assumed (This inventory shall be based on operation with 0.5% failed fuel), plus release into the coolant of:

For pressurized water reactors: 2% of the core inventory of halogens and noble gases.

For boiling water reactors: 0.2% of the core inventory of halogens and noble gases.

(b) Filter efficiencies shall be 95% for internal filters and 99% for external filters.

(c) 50% building mixing for boiling water reactors shall be assumed.

(d) For the effects of plateout, containment sprays, core sprays (values based on 0.5% of halogens in organic form) the following reduction factors shall be assumed:

For pressurized water reactors: 0.05 with chemical additives in sprays, 0.2 for no chemical additives.

For boiling water reactors: 0.2.

(e) A realistic building leak rate as a function of time and including design leakage of steamline valves in BWRs shall be assumed.

(f) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(g) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.1(a) Break in instrument line from primary system that penetrates the containment (Lines not provided with isolation capability inside containment).

(a) The primary coolant inventory of noble gases and halogens shall be based on operation with 0.5% failed fuel.

(b) Release rate through failed line shall be assumed constant for the four hour duration of the accident.

(c) Charcoal filter efficiency shall be 99%.

(d) Reduction factor from combined plateout and building mixing shall be 0.1.

(e) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.2(a) Rod ejection accident (pressurized water reactor)

(a) 0.2% of the core inventory of noble gases and halogens shall be assumed to be released into the primary coolant plus the average inventory in the primary coolant based on operation with 0.5% failed fuel.

(b) Loss-of-coolant accident occurs with break size equivalent to diameter of rod housing (See assumptions for Accident 8.1).

8.2(b) Rod drop accident (boiling water reactor)

(a) 0.025% of the core inventory of noble gas and 0.025% of the core inventory of halogens shall be assumed to be released into the coolant.

(b) 1% of the halogens in the reactor coolant shall be assumed to be released into the condenser.

(c) The mechanical vacuum pump shall be assumed to be automatically isolated by high radiation signal on the streamline.

(d) Radioactivity shall be assumed to carry over to the condenser where 10% of the halogens shall be assumed to be available for leakage from the condenser to the environment at 0.5%/day for the course of the accident (24 hours).

(e) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.3(a) Steamline breaks (pressurized water reactors–outside containment)

Small break (break size equal to area of safety valve throat)

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel. The primary system contribution during the course of the accident shall be based on a 20 gal/day tube leak.

(b) During the course of the accident a halogen reduction factor of 0.1 shall be applied to the primary coolant source when the steam generator tubes are covered; a factor of 0.5 shall be used when the tubes are uncovered.

(c) Secondary coolant system radioactivity prior to the accident shall be based on:
(1) 20 gallons per day primary-to-secondary leak.
(2) Blowdown of 10 gpm.

(d) Volume of one steam generator shall be released to the atmosphere with an iodine partition factor of 10.

(e) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel. The primary system contribution during the course of the accident shall be based on a 20 gal/day tube leak.

(b) A halogen reduction factor of 0.5 shall be applied to the primary coolant source during the course of the accident.

(c) Secondary coolant system radioactivity prior to the accident shall be based on:
(1) 20 gallons per day primary-to-secondary leak,
(2) Blowdown to 10 gpm.

(d) Volume of one steam generator shall be assumed to be released to the atmosphere with an iodine partition factor of 10.

(e) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(f) Consequences shall be calculated by weighing the effects in different directions by the frequency the wind blows in each direction.

8.3(b) Steamline breaks (boiling water reactor)

Small pipe break (of ¼ ft^2)

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel.

(b) The main steamline shall be assumed to fail releasing coolant until 5 seconds after isolation signal is received.

(c) Halogens in the fluid released to the atmosphere shall be at 1/10 the primary system liquid concentration.

(d) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(e) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel.

(b) Main steamline shall be assumed to fail releasing that amount of coolant corresponding to a 5 second isolation time.

(c) 50% of the halogens in the fluid exiting the break shall be assumed to be released to the atmosphere.

(d) Meteorology assumptions: χ/Q values shall be determined from onsite meteorological data at the 50% probability level.

(e) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

7.2 Other accidents[2]

In addition to accidents that can release radioactivity to the environs, there may be accidents that, although radioactive materials are not involved, do have consequences that affect the environment. Such accidents as chemical explosions or fires, leakage or ruptures of vessels containing oil or toxic materials can have significant environmental impacts. These possible accidents and associated effects should be identified and evaluated.

[2] The Commission's Environmental Statement will discuss the environmental impact of accidents that may occur during transport of fresh and spent fuel, irradiated fuel and radioactive wastes. See "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants", USAEC, Directorate of Regulatory Standards, December 1972, and 38 F.R. 3334 (Feb. 5, 1973).

8. ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION

The purpose of this Chapter is to present the applicant's assessment of the economic and social effects of the proposed facility.

There are, of course, limitations on the extent to which the applicant can evaluate all the social and economic benefits and costs of the construction and operation of a nuclear facility that may have a productive life of 30 years or more. The wide variety of benefits and costs are not only difficult to assess but many are not amenable to quantification nor even to estimation in commensurable units. Some primary benefits such as the generated electricity are, to a degree, measurable as are the capital costs and operating and maintenance costs of the proposed facility. On the other hand, numerous environmental costs and their economic and social consequences are not readily quantified.

Second- and higher-order costs or benefits (i.e., impacts flowing from first-order social and economic impacts) need be discussed by the applicant only where they would significantly modify the aggregate of costs or benefits, thus affecting the overall cost-benefit balance.

8.1 Benefits

The primary benefits of the proposed nuclear facility are those inherent in the value of the generated electricity which is delivered to consumers. The applicant should report, as shown in Table 1, the expected average annual kilowatt-hours of electricity to be generated. Further, a breakdown of the expected use of electricity in the applicant's service area should be provided by four major classes: residential, commercial, industrial and "other." These benefits should also be expressed in dollars by showing expected average annual revenues. The basis of assigning dollar values should be clearly stated. The year-by-year forecasts of such revenues for the life of the plant should be discounted to present worth using a nominal discount rate, reflecting the average cost of capital.

The importance of the proposed facility in providing adequate reserves of generating capacity to ensure a reliable supply for the applicant's service area (and associated power pool, if any) has been discussed in Section 1.1. Based on the estimated increase in probabilities of the extent and duration of electrical shortages if the proposed plant (or its equivalent capacity) were not built by the proposed date, the applicant should appraise the likely social and economic impacts of such events. The benefits in averting these impacts should be related to regional experience, if any, with brownouts and emergency load-shedding and the applicant's plans or methods of meeting such emergencies.

Other primary benefits of some nuclear electrical generating facilities may be in the form of sales of steam or other products or services. Revenues from such sales should be estimated. The use of waste or reject heat for desalination, or for other processes could expand the benefits of nuclear plants. Such benefits, if claimed, should be accompanied by an estimate of the degree of certainty of their realization.

There are other social and economic benefits which affect various political jurisdictions or interests to a greater or lesser degree. Some of these reflect transfer payments or other values which may partially, if not fully, compensate for certain services as well as external or environmental costs and this fact should be reflected in the designation of the benefit. A list of examples follows:

- Tax revenues to be received by local, State and Federal governments.
- Temporary and permanent new jobs created and payroll.
- Incremental increase in regional product (value-added concept).
- Enhancement of recreational values through making available for public use any parks, artifically created cooling lakes, marinas, etc.
- Enhancement of aesthetic values through any special design measures as applied to structures, artificial lakes or canals, parks, etc.
- Environmental enhancement in support of the propagation or protection of wildlife and the improvement of wildlife habitats.
- Creation and improvement of local roads, waterways, or other transportation facilities.
- Increased knowledge of the environment as a consequence of ecological research and environmental monitoring activities associated with plant operation, and technological improvements from the applicant's research program.

- Creation of a source of heated discharge which may be used for beneficial purposes (e.g., in aquaculture, in improving commercial and sport fishing, and other water sports).
- Provision of public education facilities (e.g., a visitors' center).

The applicant should discuss significant benefits that may be realized from the construction and operation of the proposed plant. Where the benefits can be expressed in monetary terms, they should be discounted to present worth. In each instance where a particular benefit is discussed, the applicant should indicate to the extent practical, who is likely to be affected and for how long. In the case of aesthetic impacts which are difficult to quantify, the applicant should provide pictorial drawings of tall structures or environmental modifications visible to the public and also of parks, or other recreational facilities on the site which will be available for public use (refer to Section 3.1).

8.2 Costs

The economic and social costs resulting from the proposed nuclear facility and its operation are likewise complex and need to be appraised.

The primary *internal* costs are: (1) the capital costs of land acquisition and improvement; (2) the capital costs of facility construction; (3) the incremental capital costs of transmission and distribution facilities; (4) fuel costs including spent fuel disposition; (5) other operating and maintenance costs including license fees and taxes; (6) plant decommissioning costs, and (7) research and development costs associated with potential future improvements of the facility and its operation and maintenance. As in the case of benefits, the applicant should discount these costs to present worth.

There are also *external* costs. Their effects on the interests of people needs to be examined. The applicant should supply, as applicable, an evaluation plus supporting data and rationale regarding such external social and economic costs as noted below.[1] For each cost, the applicant should describe the probable number and location of the population group adversely affected, the estimated economic and social impact, and any special measures to be taken to alleviate the impact.

Examples of temporary external costs:[2]

Shortages of housing; inflationary rentals or prices; congestion of local streets and highways; noise and temporary aesthetic disturbances; overloading of water supply and sewage treatment facilities; crowding of local schools, hospitals, or other public facilities; overtaxing of community services; the disruption of people's lives or the local community caused by acquisition of land for the proposed site.

Examples of long-term external costs:[3]

Impairment of recreational values (e.g., reduced availability of desired species of wildlife and sport fish, restrictions of access to land or water areas preferred for recreational use); deterioration of aesthetic and scenic values; restrictions on access to areas of scenic, historic or cultural interest; degradation of areas having historic, cultural, natural or archaeological value; removal of land from present or contemplated alternative uses; creation of locally adverse meteorological conditions (e.g., fog from cooling towers, cooling ponds, etc.); creation of noise especially by mechanical-draft cooling towers; reduction of regional product due to displacement of persons from the land proposed for the site; lost income from recreation or tourism that may be impaired by environmental disturbances; lost income of commercial fisherman attributable to environmental degradation; decrease in real estate values in areas adjacent to the proposed facility; increased costs to local governments for the services required by the permanently employed workers and their families. In discussing the costs the applicant should indicate to the extent practical, who is likely to be affected and for how long.

[1] For convenience of treatment, the listed cost examples have been divided into long-term (or continuing) costs and the temporary costs generally associated with the period of construction or the readjustment of the lives of persons whose jobs or homes will have been displaced by the purchase of land at the proposed site.

[2] Refer, as appropriate, to the information presented in Chapter 4.

[3] Refer, as appropriate, to the information presented in Chapter 5.

9. ALTERNATIVE ENERGY SOURCES AND SITES

The intent of this Chapter is to present the basis for the applicant's proposed choice of the site and nuclear fuel among the available alternative sites and energy sources. Accordingly, the applicant should discuss the range of practicable alternatives and should demonstrate that none of these is clearly to be preferred to the proposed site-plant combination. It is recognized that planning methods will differ among applicants. However, the applicant should present its site-plant selection process as the consequence of an analysis of alternatives whose environmental costs and benefits were evaluated and compared and then weighed against those of the proposed facility.

This Chapter should encompass information relevant both to the availability of alternatives and to their relative merits. Two classes of alternatives should be considered: those which can meet the power demand without requiring the creation of new generating capacity and those which do require the creation of new generating capacity.

9.1 Alternatives not requiring the creation of new generating capacity.

Practicable means which meet the projected power demand with adequate system reliability and which do not require the creation of additional generating capacity should be identified and evaluated.[1] Such alternatives may include purchased energy, reactivation or upgrading an older plant, and/or base load operation of an existing peaking facility. Such alternatives should be analyzed in terms of cost, environmental impact, adequacy, reliability and other pertinent factors. If such alternatives are totally unavailable or if their availability is highly uncertain, the relevant facts should be stated. This analysis is of major importance because it supports the justification for new generating capacity.

9.2 Alternatives requiring the creation of new generating capacity.

In this Guide an alternative constituting new generating capacity is termed a "site-plant combination" in order to emphasize that the alternatives to be evaluated should include both site and energy source options. A site-plant combination is a combination of a specific site (which may include the proposed site) and a particular category of energy source (nuclear, fossil-fueled, hydroelectric, geothermal) together with the transmission hook-up. A given site considered in combination with two different energy sources is regarded as providing two alternatives.

9.2.1 Selection of candidate areas[2]

In this section the applicant should present an initial survey of site availability using a screening process which, after identifying areas containing possible sites, then eliminates those whose less desirable characteristics are recognizable without extensive analysis. The purpose of this screening is to identify a reasonable number of realistic siting options. In assessing potential candidate areas, the applicant may place primary reliance on published materials.

The geographical regions identified may be within or outside the applicant's franchise service area. It is expected that each area considered will be small enough so that any site developed within it would have essentially similar environmental relationships (i.e. thermal discharge to the same body of water, proximity to the same urban area). The areas considered should not be restricted to those containing land actually owned by the applicant.

If a State, region or locality has a power plant siting law, the law should be cited and any applicable constraints described.

The applicant should display the areas being appraised by means of maps and charts portraying the power network[3], environmental and other features, and other relevant information. (A consistent identification system should be established and retained on all graphic and verbal material in this Section.) The map or maps should be clearly related to the applicant's service area (and adjacent areas

[1] If transmission facilities must be constructed in order to secure the energy from alternative sources, this should be discussed.

[2] As used in Chapter 9, the term "area" is defined as several square miles (large enough to contain several sites).

[3] To avoid repetition, the applicant should refer, as appropriate, to material presented in Section 1.1.

if relevant). They should display pertinent information such as the following:

a. Areas considered by the applicant;
b. Major centers of population density (urban, high, medium, low density or similar scale);
c. Water bodies suitable for use in cooling systems;
d. Railroads, highways (existing and planned), and waterways suitable for fuel and waste transportation;
e. Important topographic features (such as mountains, marshes, fault lines);
f. Dedicated land-use areas (parks, historical sites, wilderness areas, testing grounds, airports, etc.);
g. Primary generating plants, together with effective operating capacity in megawatts, both electrical and thermal, and indication of fuel (all plants of the same type at the same location should be considered as a single source);
h. Other generating additions to the network to be installed before the proposed facility goes on line;
i. Transmission lines of 115 kV or higher, and termination points on the system for proposed and potential lines from the applicant's proposed facility; and
j. Major interconnections with other power suppliers.

Maps of areas outside the applicant's service area should include the likely transmission corridor to the applicant's system.

Suitable correlations should be made among the maps. For example, one or more of the maps showing environmental features may be to the same scale as a map showing power network configurations; or present generating sites and major transmission lines may be overlaid on the environmental maps, where this is helpful to the discussion.

The applicant should briefly discuss the availability of fuel or other energy sources at the areas considered. It is recognized that conditions with regard to alternatives to nuclear fuel will vary for different applicants. Oil and coal may be readily available in many areas, although limitations on maximum sulfur content or transportation costs may restrict or prevent their use. (Where supplies are adequate, and its use is otherwise appropriate, natural gas may be an alternative in some areas). Hydroelectric and geothermal sources should also be considered if available. In some situations, combinations of energy sources (e.g., coal-fired base-load plant plus gas-turbine peaking units) may be practical alternatives. The discussion should clearly establish the energy-source alternatives.

Using the materials described above, the applicant should provide a condensed description of the major considerations which led to the final selection of the candidate areas.

The following remarks may apply in specific instances:

a. The first general geographic screening may be based on power load and transmission considerations.
b. Certain promising areas may be identified as suitable for only one type of fuel; others may be broadly defined at this stage of analysis (e.g., a stretch of coast line) and may admit several fuel-type options.
c. Only the determining characteristics of the identified areas need be discussed. Specific tracts need not be identified, unless already owned by the applicant.
d. If areas outside the service area are not considered during this phase of the decision process, the reasons for not considering them should be provided.
e. If certain fuel types are eliminated in selecting candidate areas because of predicted nonavailability or because of economic factors, supporting information should be supplied.
f. In eliminating a fuel type at a site on the grounds of monetary cost, the applicant should make clear that the excess cost over a preferred alternative outweighs any potential advantages of the eliminated fuel type with respect to environmental protection.
g. The compatability with any existing land-use planning programs of the development of each candidate area should be indicated and the views, if any, of local planning groups and interested citizens concerning use of the candidate area should be summarized.

9.2.2 Selection of candidate site-plant alternatives[4]

At this point the number of suitable areas will have been reduced, making possible the investigation of a realistic set of alternative site-plant combinations. These alternative combinations should be briefly described. The description should include any transmission considerations that significantly affect the site desirability.

[4] The range of candidate site-plant alternatives selected by the applicant should include other energy source options (coal, oil, gas, hydro, geothermal) as practicable.

The criteria to be used in selecting the candidate site-plant alternatives are essentially the criteria used in selecting candidate areas. Application of these criteria in greater depth may be required, however, since the relative merits of the various site-plant combinations may be less obvious than those of the initially identified areas. Furthermore, while a particular area may be judged unsuitable because of one major overriding disadvantage, establishment of the suitability of a given site-plant combination may require balancing both favorable and unfavorable factors (benefits versus environmental and other costs).

The applicant is not expected to conduct detailed environmental studies at alternative sites; only preliminary reconnaissance-type investigations need be conducted. Neither is it expected that detailed engineering design studies will be made for all alternative plants nor detailed transmission route studies for all alternatives.

9.3 Cost-effectiveness comparison of candidate site-plant alternatives

A cost-effectiveness analysis of realistic alternatives in terms of both economic and environmental costs should be made to show why the proposed site-plant combination is preferred over all other candidate alternatives for meeting the power requirement. In presenting the cost-effectiveness analysis, the applicant should use, insofar as possible, a tabular format showing side-by-side comparison of alternatives with respect to selection criteria.

Quantification, while desirable, may not be possible for all factors because of lack of adequate data. Under such circumstances, qualitative and general comparative statements, supported by documentation, may be used. Where possible, experience derived from operation of plants at the same or at an environmentally similar site may be helpful in appraising the nature of expected environmental impacts.

Various criteria have been suggested in this guideline for use in comparing the alternatives and the proposed facility. The criteria chosen by the applicant should reflect benefits and costs[5] which were evaluated in selecting the site-plant candidates. The following itemization of evaluatory factors may be helpful as a checklist:

Engineering and Environmental Factors:

- Geology
- Seismology
- Hydrology
- Population density in site environs
- Access to road, rail, and water transportation
- Fuel supply and waste disposal routes
- Cooling water supply
- Sensitivity of aquatic and terrestrial habitats affected
- Risks and uncertainties with regard to potential impacts
- Commitment of resources
- Projected recreational usage
- Scenic values

Transmission Hook-Up Factors:

- Access to transmission system in place
- Problems of routing new transmission lines
- Problems of transmission reliability
- Minimization of transmission losses

Construction Factors:

- Access for equipment and materials
- Access, housing, etc., for construction workers

Land Use Factors

Institutional Factors (e.g., State or regional site certification)

Cost Factors:

- Construction costs
- Costs of transmission hook-up
- Operating costs

Operating Factors:

- Load-following capability
- Transient response.

[5] The applicant may use, if the necessary data are available, the method for calculating generating costs discussed in Chapter 10.

10. PLANT DESIGN ALTERNATIVES

The applicant should, in this Chapter, show how the proposed plant design was arrived at through consideration of alternative designs of identifiable systems and through their comparative assessment.

Most of the environmental effects of a nuclear power plant will be associated with the operation of certain identifiable systems. The applicant's proposed plant should incorporate a combination of these identifiable systems each of which has been selected, through a cost-effectiveness analysis (see discussion in Introduction) of economic and other factors as the preferred choice within its category. In some instances, the interaction of these systems may be such as to require their selection on the basis of a preferred combination rather than on the basis of individual preferred systems. For example, an alternative cooling system may have to be evaluated in combination with a preferred chemical effluent system that would be used with it.

The applicant's discussion should be organized on the basis of plant systems, arranged according to the following list:

1. Cooling system (exclusive of intake and discharge)
2. Intake system
3. Discharge system
4. Chemical waste treatment
5. Biocide treatment
6. Sanitary waste system
7. Liquid radwaste systems
8. Gaseous radwaste systems
9. Transmission facilities
10. Other systems

The following should be considered in preparing the discussion:

a. **Range of alternatives**–The applicant's discussion should emphasize those alternative plant systems that appear promising in terms of environmental protection. Different designs for systems that are essentially identical with respect to environmental effects should be considered only if their costs are appreciably different. The applicant should include alternatives which provide levels of environmental protection above those of the proposed facility when, although not necessarily economically attractive, they are practicable on technological grounds.

b. **Normalization of cost comparison**–Alternatives should be compared on the basis of assuming a fixed amount of energy generated for distribution outside the plant. (Thus, any effect of an alternative on plant power consumption should be discussed.)

c. **Effect of capacity factor**–Where the plant capacity factor is effectively determined by the cost of operation, the projected effect of alternatives on plant capacity factor should be stated and explained.

d. **Monetized costs**–The acquisition and operating costs of individual systems and their alternatives (as well as costs of the total plant and transmission facility and alternatives) are to be expressed as power generating costs. The latter will be derived from cost elements compounded or discounted (as appropriate) to their present values as of the date of initial commercial operation and will be converted to their annualized values. The method of computation is shown in Table 2 and the individual cost items in this table are to be used as applicable. The total cost will be the sum of:

Capital to be expended up until the scheduled date of operation.[1]

Interest to the date of operation on all expenditures prior to that date.

Expenditures subsequent to the scheduled date of operation discounted to that date. In calculations, the applicant should assume a 30-year plant life.[2]

In computing the annualized present value of plant systems and their alternatives, the following cost elements are suggested as allowable:

Engineering design and planning costs.

Construction costs.

Interest on capital expended prior to operation.

Operating, maintenance and fuel (if applicable) costs over the 30-year life of the plant.

[1] For operating license proceedings, costs should be based on capital to be expended to complete the facility.

[2] Use 30-year life for steam-electric generating plants. For other types of electric generating plants, use generally accepted values.

Cost of modification on alteration of any other plant system is required for accommodation of alternatives to maintain plant capacity (see item b above).

Maintenance costs for the transmission facility (if applicable).

Cost of supplying make-up power during a delay resulting from an alternative design choice which will not meet the power requirement by the scheduled in-service date.

Environmental costs.—Environmental effects of alternatives should be fully documented. To the extent practicable, the magnitude of each effect should be quantified. Where quantification is not possible, qualitative evaluations should be expressed in terms of comparison to the effects of the subsystem chosen for the proposed design. In either case, the derivation of the evaluations should be completely documented.

Table 3 presents a set of environmental factors which should be considered in comparing alternative plant systems in the cost-effectiveness analysis. Although incomplete, the factors listed are believed to represent the principal environmental effects of power plant construction and operation that can be evaluated by generally accepted techniques. The table provides for three key elements of environmental cost evaluation:

(1) A description of each effect to be measured (column 3).
(2) Suggested units to be used for measurement (column 4). The AEC recognizes the difficulty, if not the impossibility, of using the assigned units for every item in Table 3 in each case, given the current state-of-the-art. The applicant may elect to use other units, provided they are meaningful to the informed public and adequately reflect the impact of the listed environmental effects.
(3) A suggested methodology of computation (column 5). Computation of effects in response to each block in Table 3, e.g., 1.1, 1.2 etc., should be given without adjustment for effects computed in other blocks for the same population or resource affected. However, provision is made in Table 3 (i.e., 1.9 and 4.9) to account for combined effects that may be either less than or greater than the sum of individual effects.

In discussing environmental effects, the applicant should specify not only the magnitude of the effect (e.g., pounds of fish killed, acres of a particular habitat destroyed) but also the relative effect, that is the fraction of the population or resource that is affected. See discussion in Section 5.8.

In some specific cases, accurate estimation of an effect which the applicant believes to be very small may require a data collection effort that would not be commensurate with the value of the infomation to be obtained. In such cases, the applicant may substitute a preferred measure which conservatively estimates environmental costs for the effect in question, provided the substituted measure is clearly documented and realistically evaluates the potentially detrimental (i.e., worst case) aspects of the effect, and provided the measure is applied consistently to all alternatives.

f. **Supporting details**—In the following subsections, the applicant should discuss design alternatives for each of the relevant plant systems (i.e., cooling system, intake system, etc.). The discussion should describe each alternative, present estimates of its environmental impact and compare the estimated impact with that of the proposed system. The assumptions and calculations on which the estimates are based should be presented. Engineering design and supporting studies, e.g., thermal modeling, performed to assess the impact of alternative plant systems should be limited in scope to those efforts required to support the cost-effectiveness analysis which led to selection of the proposed design.

g. **Presentation of alternative designs**—The results should be tabulated for each plant system. Table 4 shows the basic form recommended for presentation of alternative plant systems. Table 5 shows the recommended tabulation to be used in comparing alternative transmission routes. In the columns headed "Page," the applicant should cite the appropriate references to the text of the Report. Note that, in the tables, the categorization and numerical identification of each environmental effect corresponds to that of Table 3. In each of the tables used in Sections 10.1 to 10.9 the applicant should include, in the first "A" column, data on the system selected in the applicant's proposed design.

Each table provides for the display of data regarding four alternatives; however, the applicant is neither obligated to consider, nor limited to, any precise number. The applicant should limit the discussion to those alternatives which the current state-of-the-art indicates are technically practicable.

The monetized costs of the proposed systems and alternatives should be presented on an incremental basis. This means that the costs of the proposed systems would appear as zeroes in the "A" columns of the tables and that the costs of the other alternative systems (B, C, D, etc.) should appear as cost differences, i.e., B–A, C–A, etc., with negative values enclosed in parentheses. The environmental costs are not incremental and the tabulations

should therefore show these as the total costs, whether monetized or not. (If an environmental effect is considered beneficial, the entry should be enclosed in parentheses.)

In addition to the information displayed in the tables, the applicant should provide a verbal description of the process by which the trade-offs were weighed and balanced in arriving at the proposed design. This discussion may include any factors not provided for on the tabulations.

10.1 Cooling system (exclusive of intake and discharge)

The applicant should identify and describe cooling system alternatives to the proposed design. Estimates of environmental effects should be prepared and tabulated.

10.2 Intake system

The applicant should identify and describe intake system alternatives to the proposed design. Estimates of environmental effects should be prepared and tabulated.

10.3 Discharge system

The applicant should identify and describe discharge system alternatives to the proposed design. Estimates of environmental effects should be prepared and tabulated.

10.4 Chemical waste treatment

Alternative chemical systems that have the potential for reduced adverse environmental effects should be described and the environmental impacts of effluents should be fully identified. Corrosion products as well as corrosion inhibitors should be considered.

The description should include specification of both maximum and average concentrations and dilution sources. (Where a discharge is not continuous, the discharge schedule should be specified.) Any toxicity and lethality to affected biota should be documented for all potential points of exposure. Specifically, information should be sufficient to define the impacts to entrained organisms at their points of exposure as well as the impacts beyond the point of discharge. Estimates of environmental effects should be prepared and tabulated.

10.5 Biocide treatment

The applicant should describe alternative means for control of fouling organisms, including both mechanical and chemical methods where such alternatives may be expected to have less severe environmental effects than the proposed system. The treatment of chemical biocides should be similar to that specified above for chemical effluent treatment. Estimates of environmental effects should be prepared and tabulated.

10.6 Sanitary waste system

Alternative sanitary waste systems should be identified and discussed with regard to the environmental implications of both waste products and chemical additives for waste treatment. Estimates of environmental effects should be prepared and tabulated.

10.7 Liquid radwaste systems

For proposed light-water cooled reactor installations in which the quantities of radioactive material in effluents will be limited to levels that are within the numerical guides for design objectives and limiting conditions of operation set forth in the Commission's proposed amendments (dated June 9, 1971) to 10 CFR Part 50 and embodied in a new Appendix I, no further consideration need be given to the reduction of radiological impacts in formulating alternative plant designs. If the reactor is not a light-water cooled reactor, the possibility must be explored of an alternative radwaste system which reduces the level of radioactivity in the effluents and direct radiation to the levels proposed in Appendix I. In any case for reactors to which the proposed Appendix I does not apply, the applicant should demonstrate sufficient consideration of alternative radwaste systems and of their radiological output to assure that releases from the proposed facility will be as low as practicable.

10.8 Gaseous radwaste systems

Consideration of systems for the disposal of gaseous radwaste is subject to the qualifying condition noted under 10.7 above.

10.9 Transmission facilities

The applicant should discuss the cost and environmental effects of alternative routes for new transmission facilities required for tie-in of the proposed facility to the applicant's system. The documentation should include maps of the alternative routes. These maps should clearly indicate topographic features important to evaluation of the routes and boundaries of visually sensitive areas. The applicant may find the documents cited in Section 3.9 helpful in this analysis. Estimates of environmental effects should be prepared and tabulated.

10.10 Other systems

Any plant system, other than those specified above, which is associated with an adverse environmental effect, should be discussed in terms of practicable and feasible alternatives that may reduce or eliminate this environmental effect.

11. SUMMARY BENEFIT-COST ANALYSIS

This Chapter should demonstrate through a benefit-cost analysis of the proposed plant why in the applicant's judgement the aggregate benefits outweigh the aggregate costs. Although the Commission will independently prepare a cost-benefit analysis of the proposed plant in the Environmental Statements, nevertheless, the applicant should perform its own analysis in order to aid the Commission in its evaluation.

While the benefit-cost analysis approach discussed in this Guide is conceptually similar to the benefit-cost approach classically employed in a purely economic context, the method recommended differs from it procedurally. This is because the benefits and costs to be evaluated will not all be monetized by the applicant. The incommensurable nature of the benefits and costs makes it virtually impossible to provide a concise assessment of benefits vs. costs in classical quantitative terms. However, although a simple numerical weighing of benefits against costs is clearly not feasible here, nevertheless the applicant can evaluate the factors on a judgmental basis which is consistent with the underlying concept of benefit-cost analysis.

The following considerations may be helpful to the applicant in preparing the analysis. As indicated above, it is incumbent on the applicant to demonstrate that the benefits of the proposed facility are considered to outweigh the aggregate costs. Beyond this, the degree to which the benefits may outweigh the costs is a factor which will be considered in the Commission's Environmental Statement. In selecting each proposed plant system from a set of alternative systems, the cost-effectiveness analysis of Chapter 10 will have maximized the net benefit (i.e., aggregate of benefits minus the costs).

In presenting the cost-benefit analysis the applicant should first consider the benefits identified and described in Chapters 1 and 8. Secondly, generating, environmental, and other cost items, identified in Chapters 4, 5, 8, and 10 should be considered; these costs should be summarized in a tabulation as shown in Table 6.

12. ENVIRONMENTAL APPROVALS AND CONSULTATION

List and give the status of all licenses, permits and other approvals of plant construction and operations required by Federal, State, local and regional authorities for the protection of the environment.

List all laws or ordinances applicable to the proposed transmission system and the status of approvals that must be obtained. Indicate any public hearings held or to be held with respect to the proposed transmission system.

The listing should cite the relevant statutory or other authority requiring approvals with respect to the construction and/or operation of the plant and should be categorized by the environmental impact to which the approval is addressed. These categories could include, for example, air, land and water use and planning, fish diversion, and construction effects.

Discuss the status of efforts to obtain a water quality certification under Section 401 of the Federal Water Pollution Control Act, as amended. If not already obtained, indicate when certification is expected. If certification is not required, explain.

If the discharge could alter the quality of the water or air of another State, indicate the State or States that may be affected and their applicable limitations, standards, or regulations.

In view of the effects of the plant on the economic development of the region in which it is located, the applicant should also note the State, local, and regional planning authorities contacted or consulted. The OMB Circular A-95 identifies the State, metropolitan, and regional clearinghouses that should be contacted as appropriate. (A listing of the clearinghouses which serve a particular site area may be obtained from the AEC.)

Meetings held with environmental and other citizen groups, if any, should be cited and reference given to specific instances of the applicant's responses to citizen group recommendations.

13. REFERENCES

The applicant should provide a bibliography of sources used in preparation of the Environmental Report. References cited should be keyed to the specific chapters to which they apply.

TABLES

Table 1 BENEFITS FROM THE PROPOSED FACILITY

Direct Benefits

Expected average annual generation in kilowatt-hours .....
Capacity in kilowatts .....
Proportional distribution of electrical energy
(Expected annual delivery in kilowatt-hours):
Industrial .....
Commercial .....
Residential .....
Other .....
Expected average annual Btu (in millions) of steam sold from the facility .....
Expected average annual delivery of other beneficial products (appropriate physical units) .....
Revenues from delivered benefits:
Electrical energy generated .....
Steam sold .....
Other products .....

Indirect Benefits (as appropriate)

Taxes (local, State, Federal) .....
Research .....
Regional product .....
Environmental enhancement:
Recreation .....
Navigation .....
Air Quality:
SO_2 .....
NO_x .....
Particulates .....
Others .....
Employment .....
Education .....
Others .....

Table 2 MONETIZED BASES FOR GENERATING COSTS*

ITEM	SYMBOL	UNITS	ITEM DESCRIPTION
Total outlay required to bring facility to operation	C_I	$	All capital outlays including interest expense to be invested in completion of the facility compounded to present value as of the scheduled in-service date of operation.
Annual operating cost	O_t	$	This is the total operating and maintenance cost of plant operation in year t.
Annual fuel cost	F_t	$	This is the total fuel cost in year t.
Cost of makeup power purchased or supplied in year t	P_t	$	Cost of power purchased or supplied internally in year t to make up deficiency of power associated with any alternative which introduces delay.
Discount factor	ν		$\nu = (1 + i)^{-1}$ where i is the applicant's estimated average cost of capital over the life of this plant.
Total generating cost – present value	GC_p	$	$GC_p = C_I + \sum_{t=1}^{30} \nu^t (O_t + F_t) + \sum_{t=1}^{30} \nu^t P_t$
Total generating cost – present value annualized	GC_a	$	$GC_a = GC_p \times \frac{i(1+i)^{30}}{(1+i)^{30}-1}$

*For conventional (nuclear or fossil fuel) steam-electric plants.

Table 3 ENVIRONMENTAL FACTORS TO BE USED IN COMPARING ALTERNATIVE PLANT SYSTEMS

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
1. Natural surface water body	(Specify natural water body affected)			
1.1 Impingement or entrapment by cooling water intake structure	1.1.1 Fish[2]	Juveniles and adults are subject to attrition.	Percent of harvestable or adult population destroyed per year for each important species.	Identify all important species as defined in Sect. 2.7. Estimate the annual weight and number of each species that will be destroyed. (For juveniles destroyed, only the expected population that would have survived naturally need be considered.) Compare with the estimated weight and number of the species population in the water body.
1.2 Passage through or retention in cooling systems	1.2.1 Phytoplankton and zooplankton	Plankton population (excluding fish) may be changed due to mechnical, thermal and chemical effects.	Percent changes in production rates and species diversity.	Field studies are required (1) to estimate the diversity and production rates of readily recognizable groups (e.g. diatoms, green algae, zooplankton) and (2) to estimate the mortality of organisms passing through the condenser and pumps. Include indirect[3] effects which affect mortality.
	1.2.2 Fish	All life stages (eggs, larvae, etc.) which reach the condenser are subject to attrition.	Percent of harvestable or adult population destroyed per year for each important species.	Identify all important species as defined in Sect. 2.7. Estimate the annual weight and number of each species that will be destroyed. (For larvae, eggs, and juveniles destroyed, only the expected population that would have survived naturally need be considered.) Compare with the estimated weight and number of the species population in the water body.
1.3 Discharge area and thermal plume	1.3.1 Water quality, excess heat	The rate of dissipation of the excess heat, primarily to the atmosphere, will depend on both the method of discharge and the state of the receiving water, in respect to ambient temperature and water currents.	Acres and acre-feet.	Estimate the average Btu's per hour dissipated to the receiving water at full power. Estimate the water volume and surface areas within differential temperature isotherms of 2°, 3°, and 5°F under conditions that would tend, with respect to annual variations, to maximize the extent of the areas and volumes.
	1.3.2 Water quality, oxygen availability	Dissolved oxygen concentration of receiving waters may be modified as a consequence of changes in the water temperature, the translocation of water of different quality, and aeration.	Acre-feet.	Estimate volumes of affected waters with concentrations below 5, 3, and 1 ppm under conditions that would tend to maximize the impact.
	1.3.3 Fish (nonmigratory)	Fish[2] may be affected directly or indirectly[3] due to adverse conditions in the plume.	Net effect in pounds per year (as harvestable or adult fish by species of interest).	Field measurements are required to establish the average number and weight (as harvestable or adults) of important species (as defined in Sect. 2.7). Estimate their mortality in the receiving water from direct and indirect[3] effects.

[1] Applicant may substitute an alternative unit of measure, where convenient. Such a measure should be related quantitatively to the unit of measure shown in this table.
[2] "Fish" as used in this table includes shellfish and other aquatic invertebrates harvested by man.
[3] Indirect effects could include increased disease incidence, increased predation, interference with spawning, changed metabolic rates, hatching of fish out of phase with food organisms.

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
	1.3.4 Fish (migratory)	Suitable habitats (wetland or water surface) may be affected.	Acres of defined habitat or nesting area.	Determine the areas impaired as habitats because of thermal discharges, including effects on food resources. Document estimates of affected population by species.
	1.3.5 Wildlife (including birds, aquatic and amphibious mammals and reptiles).	A thermal barrier may inhibit migration, both hampering spawning and diminishing the survival of returning fish.	Pounds per year (as adult or harvestable fish by species of interest).	Estimate the fraction of the stock that is prevented from reaching spawning grounds because of plant operation. Prorate this directly to a reduction in current and long-term fishing effort supported by that stock. Justify estimate on basis of local migration patterns, experience at other sites, and applicable State standards.
1.4 Chemical effluents	1.4.1 Water quality, chemical	Water quality may be impaired.	Acre-feet, %.	The volume of water required to dilute the average daily discharge of each chemical to meet applicable water quality standards should be calculated. Where suitable standards do not exist, use the volume required to dilute each chemical to a concentration equivalent to a selected lethal concentration for the most important species (as defined in Sect. 2.7) in the receiving waters. The ratio of this volume to the annual minimum value of the daily net flow, where applicable, of the receiving waters should be expressed as a percentage, and the largest such percentage reported. Include the total solids if this is a limiting factor. Include in this calculation the blowdown from cooling towers.
	1.4.2 Fish	Aquatic populations may be affected by toxic levels of discharge chemicals or by reduced dissolved oxygen concentrations.	Pounds per year (by species as fish).	Total chemical effect on important species of aquatic biota should be estimated. Biota exposed within the facility should be considered as well as biota in receiving waters. Supporting documentation should include reference to applicable standards, chemicals discharged and their toxicity to the aquatic populations affected.
	1.4.3 Wildlife (Including birds, aquatic and amphibious mammals, and reptiles).	Suitable habitats for wildlife may be affected.	Acres.	Estimate the area of wet land or water surface impaired as a wildlife habitat because of chemical contamination including effects on food resources. Document estimates of affected population by species.
	1.4.4 People	Recreational water uses (boating, fishing, swimming) may be inhibited.	Lost annual user days and area (acres) or shoreline miles for dilution.	Volume of the net flow to the receiving waters required for dilution to reach accepted water quality standards must be determined on the basis of daily discharge and converted to either surface area or miles of shore. Cross section and annual minimum flow characteristics should be incorporated where applicable. Annual number of visitors to the affected area or shoreline must be obtained. This permits estimation of lost user-days on an annual basis. Any possible eutrophication effects should be estimated and included as a degradation of quality.

*See footnotes at beginning of table.

TABLE 3 (continued)*

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
1.5 Radionuclides discharged to water body	1.5.1 Aquatic organisms	Radionuclide discharge may introduce a radiation level which adds to natural background radiation.	Rad per year.	Sum dose contributions from radionuclides expected to be released.
	1.5.2 People, external	Radionuclide discharge may introduce a radiation level which adds to natural background radiation for water users.	Rem per year for individual; man-rem per year for estimated population as of the first scheduled year of plant operation.	Sum annual dose contributions from nuclides expected to be released. Calculate for above-water activities (skiing, fishing, boating), in-water activities (swimming), and shoreline activities.
	1.5.3 People, ingestion	Radionuclide discharge may introduce a radiation level which adds to natural background radiation for ingested food and water.	Rem per year for individuals (whole body and organ); man-rem per year for population as of first scheduled year of plant operation.	Estimate biological accumulation in foods, and intake by individuals and population. Calculate doses by summing results for expected radionuclides.
1.6 Consumptive use	1.6.1 People	Drinking water supplies drawn from the water body may be diminished.	Gallons per year.	Where users withdraw drinking water supplies from the affected water body, lost water to users should be estimated. Relevant delivered costs of replacement drinking water should be included.
	1.6.2 Agriculture	Water may be withdrawn from agricultural usage and use of remaining water may be degraded.	Acre-feet per year.	Where users withdrawing irrigation water are affected, the loss should be evaluated as the sum of two volumes: the volume of the water lost to agricultural users and the volume of dilution water required to reduce concentrations of dissolved solids in remaining water to an agriculturally acceptable level.
	1.6.3 Industry	Water may be withdrawn for industrial use.	Gallons per year.	
1.7 Plant construction (including site preparation)	1.7.1 Water quality, physical	Turbidity, color or temperature of natural water body may be altered.	Acre-feet and acres.	The volume of dilution water required to meet applicable water quality standards should be calculated. The areal extent of the effect should be estimated.
	1.7.2 Water quality, chemical	Water quality may be impaired.	Acre-feet, %.	To the extent possible, the applicant should treat problems of spills and drainage during construction in the

*See footnotes at beginning of table.

Table 3 (continued)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
1.8 Other impacts				The applicant should describe and quantify any other environmental effects of the proposed plant which are significant.
1.9 Combined or interactive effects				Where evidence indicates that the combined effect of a number of impacts on a particular population or resource is not adequately indicated by measures of the separate impacts, the total combined effect should be described.
1.10 Net effects				See discussion in Section 5.8.

Table 3 (continued)*

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
2. Ground Water				
2.1 Raising/lowering of ground water levels	2.1.1 People	Availability or quality of drinking water may be decreased and the functioning of existing wells may be impaired.	Gallons per year.	Volume of replacement water for local wells actually affected must be estimated.
	2.1.2 Plants	Trees and other deep-rooted vegetation may be affected.	Acres.	Estimate the area in which ground water level change may have an adverse effect on local vegetation. Report this acreage on a separate schedule by land use. Specify such uses as recreational, agricultural and residential.
2.2 Chemical contamination of ground water (excluding salt)	2.2.1 People	Drinking water of nearby communities may be affected.	Gallons per year.	Compute annual loss of potable water.
	2.2.2 Plants	Trees and other deep-rooted vegetation may experience toxic effects.	Acres.	Estimate area affected and report separately by land use. Specify such uses as recreational, agricultural and residential.
2.3 Radionuclide contamination of ground water	2.3.1 People	Radionuclides which enter ground water may add to natural background radiation level for water and food supplies.	Rem per year for individuals (whole body and organ); man-rem per year for population as of year of first scheduled year of plant operation.	Estimate intakes by individuals and populations. Sum dose contributions for nuclides expected to be released.
	2.3.2 Plants and animals	Radionuclides which enter ground water may add to natural background radiation level for local plant forms and animal population.	Rad per year.	Estimate uptake in plants and transfer to animals. Sum dose contributions for nuclides expected to be released.
2.4 Other impacts on ground water				The applicant should describe and quantify any other environmental effects of the proposed plant which are significant.

*See footnotes at beginning of table.

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
3. Air				
3.1 Fogging and icing (caused by evaporation and drift)	3.1.1 Ground transportation	Safety hazards may be created in the nearby regions in all seasons.	Vehicle-hours per year	Compute the number of hours per year that driving hazards will be increased on paved highways by fog and ice from cooling towers and ponds. Documentation should include the visibility criteria used for defining hazardous conditions on the highways actually affected.
	3.1.2 Air transportation	Safety hazards may be created in the nearby regions in all seasons.	Hours per year, flights delayed per year.	Compute the number of hours per year that commercial airports will be closed to visual (VFR) and instrumental (IFR) air traffic because of fog and ice from cooling towers. Estimate number of flights delayed per year.
	3.1.3 Water transportation	Safety hazards may be created in the nearby regions in all seasons.	Hours per year, number of ships affected per year.	Compute the number of hours per year ships will need to reduce speed because of fog from cooling towers or ponds or warm water added to the surface of the river, lake or sea.
	3.1.4 Plants	Damage to timber and crops may occur through introduction of adverse conditions.	Acres by crop.	Estimate the acreage of potential plant damage by crop.
3.2 Chemical discharge to ambient air	3.2.1 Air quality, chemical	Pollutant emissions may diminish the quality of the local ambient air.	% and pounds or tons.	The actual concentration of each pollutant in ppm for maximum daily emission rate should be expressed as a percentage of the applicable emission standard. Report weight for expected annual emissions.
	3.2.2 Air quality, odor	Odor in gaseous discharge or from effects on water body may be objectionable.	Statement.	A statement must be made as to whether odor originating in plant is perceptible at any point off-site.
3.3 Radionuclides discharged to ambient air and direct radiation from radioactive materials (in-plant or being transported).	3.3.1 People, external	Radionuclide discharge or direct radiation may add to natural background radiation level.	Rem per year for individuals (whole body and organ); man-rem per year for population as of year of first scheduled operation.	Sum dose contributions from nuclides expected to be released.
	3.3.2 People, ingestion	Radionuclide discharge may add to the natural radioactivity in vegetation and in soil.	Rem per year for individuals (whole body and organ); man-rem per year for	For radionuclides expected to be released estimate deposit and accumulation in foods. Estimate intakes by individuals and populations and sum results for all expected radionuclides.

*See footnotes at beginning of ta

Table 3 (continued)*

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
			population as of year of first scheduled operation.	
	3.3.3 Plants and animals	Radionuclide discharge may add to natural background radioactivity of local plant and animal life.	Rad per year.	Estimate deposit of radionuclides on, and uptake in plants and animals. Sum dose contributions for radionuclides expected to be released.
3.4 Other impacts on air				The applicant should describe and quantify any other environmental effects of the proposed plant which are significant.

*See footnotes at beginning of table.

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
4. Land				
4.1 Site selection	4.1.1 Land, amount	Land will be preempted for construction of nuclear power plant, plant facilities, and exclusion zone.	Acres.	State number of acres preempted for plant, exclusion zone, and accessory facilities such as cooling towers and ponds. By separate schedule state the type and class of land preempted (e.g., scenic shoreline, wet land, forest land, etc.).
4.2 Construction activities (including site preparation)	4.2.1 People (amenities)	There will be a loss of desirable qualities in the environment due to the noise and movement of men, material and machines.	Total population affected, years.	The disruption of community life (or alternatively the degree of community isolation from such irritations) should be estimated. Estimate the number of residences, schools, hospitals, etc., within area of visual and audio impacts. Estimate the duration of impacts and total population affected.
	4.2.2 People (accessibility of historical sites)	Historical sites may be affected by construction	Visitors per year.	Determine historical sites that might be displaced by generation facilities. Estimate effect on any other sites in plant environs. Express net impact in terms of annual number of visitors.
	4.2.3 People (accessibility of archeological sites)	Construction activity may impinge upon sites of archaeological value.	Qualified opinion.	Summarize evaluation of impact on archeological resources in terms of remaining potential value of the site. Referenced documentation should include statements from responsible county, State or Federal agencies, if available.
	4.2.4 Wildlife	Wildlife may be affected.	Qualified opinion.	Summarize qualified opinion including views of cognizant local and State wildlife agencies when available, taking into account both beneficial and adverse affects.
	4.2.5 Land (erosion)	Site preparation and plant construction will involve cut and fill operations with accompanying erosion potential.	Cubic yards and acres.	Estimate soil displaced by construction activity and erosion. Beneficial and detrimental effects should be reported separately.
4.3 Plant operation	4.3.1 People (amenities)	Noise may induce stress.	Number of residents, school populations, hospital beds.	Use the Proposed HUD Criterion Guideline for Non-Aircraft Noise to establish areas receiving noise in the categories of "Clearly Unacceptable," "Normally Unacceptable" and "Normally Acceptable." For each area report separately the number of residences, the total school population, and the total number of hospital beds.
	4.3.2 People (aesthetics)	The local landscape as viewed from adjacent residential areas and neighboring historical, scenic, and recreational sites may be rendered	Qualified opinion.	Summarize qualified opinion including views of cognizant local and regional authorities when available.

*See footnotes at beginning of table.

Table 3 (continued)*

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
		aesthetically objectionable by the plant facility.		
	4.3.3 Wildlife	Wildlife may be affected.	Qualified opinion.	Summarize qualified opinion including views of cognizant local and State wildlife agencies when available, taking into account both beneficial and adverse effects.
	4.3.4 Land, flood control	Health and safety near the water body may be affected by flood control.	Reference to Flood Control District approval.	Reference must be made to regulations of cognizant Flood Control Agency by use of one of the following terms: Has NO IMPLICATIONS for flood control, COMPLIES with flood control regulation.
4.4 Salts discharged from cooling towers	4.4.1 People	Intrusion of salts into groundwater may affect water supply.	Pounds per square foot per year.	Estimate the amount of salts discharged as drift and particulates. Report maximum deposition. Supporting documentation should include patterns of deposition and projection of possible effect on water supplies.
	4.4.2 Plants and animals	Deposition of entrained salts may be detrimental in some nearby regions.	Acres.	Salt tolerance of local affected area vegetation must be determined. That area, if any, receiving salt deposition in excess of tolerance (after allowance for dilution) must be estimated. Report separately an appropriate tabulation of acreage by land use. Specify such uses as recreational, agricultural and residential. Where wildlife habitat is affected identify populations.
	4.4.3 Property resources	Structures and movable property may suffer degradation from corrosive effects.	Dollars per year.	If salt spray impinges upon a local community, then property damage may be estimated by applying to the local value of buildings, machinery, and vehicles a differential in average depreciation rates between this and a comparable sea-coast community.
4.5 Transmission route selection	4.5.1 Land, amount	Land will be preempted for construction of transmission line systems.	Miles, acres.	State total length and area of new rights-of-way. Estimate current market value of land involved.
	4.5.2 Land use and land value	Lines may pass through visually sensitive (that is sensitive to presence of transmission lines and towers) areas, thus impinging on their present and potential use and value of neighboring property.	Miles, acres, dollars.	Total length of new transmission lines and area of right-of-way through various categories of visually sensitive land. Estimate minimum loss in current property values of adjacent areas.
	4.5.3 People (aesthetics)	Lines may present visually undersirable features.	Number of such features.	Estimate total number of visually undesirable features, such as: number of major road crossings in vicinity of intersection or interchanges; number of major waterway crossings; number of crest, ridge, or other high point crossings; number of "long views" of transmission lines perpendicular to highways and waterways.

Table 3 (concluded)*

Primary Impact	Population or Resources Affected	Description	Unit of Measure[1]	Method of Computation
4.6 Transmission facilities construction	4.6.1 Land adjacent to right-of-way	Constructing new roads for access to right-of-way may have environmental impact.	Miles.	Estimate length of new access and service roads required for alternative routes.
	4.6.2 Land, erosion	Soil erosion may result from construction activities.	Tons per year.	Estimate area with increased erosion potential traceable to construction activities.
	4.6.3 Wildlife	Wildlife habital and access to habitat may be affected.	Number of important species affected.	Identify important (Sect. 2.7) species that may be disturbed.
	4.6.4 Flora	Flora may be affected.		
4.7 Transmission line operation	4.7.1 Land Use	Land preempted by right-of-way may be used for additional beneficial purposes such as orchards, picnic areas, nurseries, hiking and riding trails.	%, dollars.	Estimate percent of right-of-way for which no multiple use activities are planned. Annual value of multiple use activities less cost of improvements.
	4.7.2 Wildlife	Modified wildlife habitat may result in changes.	Qualified opinion.	Summarize qualified opinion including views of cognizant local and State wildlife agencies when available.
4.8 Other land impacts				The applicant should describe and quantify any other environmental effects of the proposed plant which are significant.
4.9 Combined or interactive effects				Where evidence indicates that the combined effects of a number of impacts on a particular population or resource are not adequately indicated by measures of the separate impacts, the total combined effect should be described. Both beneficial and adverse interactions should be indicated.
4.10 Net effects				See discussion in Section 5.8.

*See footnotes at beginning of table.

Table 4 BASIC TABULATION TO BE USED IN COMPARING ALTERNATIVE PLANT SYSTEMS

ALTERNATIVES		A		B		C		D	
INCREMENTAL GENERATING COST	Present Worth								
	Annualized								
CAPACITY FACTOR									
ENVIRONMENTAL COSTS*	UNITS	Magnitude	Page	Magnitude	Page	Magnitude	Page	Magnitude	Page
1. NATURAL SURFACE WATER BODY									
1.1 Impingement or entrapment by cooling water intake structure									
1.1.1 Fish									
1.2 Passage through or retention in cooling systems									
1.2.1 Phytoplankton and zooplankton									
1.2.2 Fish									
1.3 Discharge area and thermal plume									
1.3.1 Water quality, excess heat									
1.3.2 Water quality, oxygen availability									
1.3.3 Fish, nonmigratory									
1.3.4 Fish, migratory									
1.3.5 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)									
1.4 Chemical effluents									
1.4.1 Water quality, chemical									
1.4.2 Fish									
1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)									
1.4.4 People									
1.5 Radionuclides discharged to water body									
1.5.1 Aquatic organisms									
1.5.2 People, external									
1.5.3 People, ingestion									
1.6 Consumptive use									
1.6.1 People									
1.6.2 Agriculture									
1.6.3 Industry									

* See Table 3 for definition of environmental costs. For each plant system, certain of the tabulated costs will be applicable and others will not.

Table 4 (continued)

ENVIRONMENTAL COSTS	UNITS	ALTERNATIVES A Magnitude	A Page	B Magnitude	B Page	C Magnitude	C Page	D Magnitude	D Page
1.7 Plant construction (including site preparation)									
1.7.1 Water quality, physical									
1.7.2 Water quality, chemical									
1.8 Other impacts									
1.9 Combined or interactive effects									
1.10 Net effects									
2. GROUND WATER									
2.1 Raising/lowering of ground water levels									
2.1.1 People									
2.1.2 Plants									
2.2 Chemical contamination of ground water (including salt)									
2.2.1 People									
2.2.2 Plants									
2.3 Radionuclide contamination of ground water									
2.3.1 People									
2.3.2 Plants and animals									
2.4 Other impacts on ground water									
3. AIR									
3.1 Fogging and icing (caused by evaporation and drift)									
3.1.1 Ground transportation									
3.1.2 Air transportation									
3.1.3 Water transportation									
3.1.4 Plants									

Table 4 (continued)

ENVIRONMENTAL COSTS	UNITS	ALTERNATIVES A Magnitude	A Page	B Magnitude	B Page	C Magnitude	C Page	D Magnitude	D Page
3.2 Chemical discharge to ambient air									
3.2.1 Air quality, chemical									
3.3.2 Air quality, odor									
3.3 Radionuclides discharged to ambient air and direct radiation from radioactive materials									
3.3.1 People, external									
3.3.2 People, ingestion									
3.3.3 Plants and animals									
3.4 Other impacts on air									
4. LAND									
4.1 Site selection									
4.1.1 Land, amount									
4.2 Construction activities (including site preparation)									
4.2.1 People (amenities)									
4.2.2 People (accessibility of historical sites)									
4.2.3 People (accessibility of archaeological sites)									
4.2.4 Wildlife									
4.2.5 Land (erosion)									
4.3 Plant operation									
4.3.1 People (amenities)									
4.3.2 People (aesthetics)									
4.3.3 Wildlife									
4.3.4 Land, flood control									

Table 4 (concluded)

ENVIRONMENTAL COSTS	UNITS	ALTERNATIVES A Magnitude	A Page	B Magnitude	B Page	C Magnitude	C Page	D Magnitude	D Page
4.4 Salts discharged from cooling towers									
4.4.1 People									
4.4.2 Plants and animals									
4.4.3 Property resources									
4.5 Transmission route selection									
4.5.1 Land, amount									
4.5.2 Land use and land value									
4.5.3 People (aesthetics)									
4.6 Transmission facilities construction									
4.6.1 Land adjacent to right-of-way									
4.6.2 Land, erosion									
4.6.3 Wildlife									
4.6.4 Flora									
4.7 Transmission line operation									
4.7.1 Land use									
4.7.2 Wildlife									
4.8 Other land impacts									
4.9 Combined or interactive effects									
4.10 Net effects									

Table 5 BASIC TABULATION TO BE USED IN COMPARING ALTERNATIVE TRANSMISSION ROUTES

	ALTERNATIVES	A		B		C		D	
INCREMENTAL GENERATING COST	Present Worth								
	Annualized								
CAPACITY FACTOR									
ENVIRONMENTAL COSTS	UNITS	Magnitude	Page	Magnitude	Page	Magnitude	Page	Magnitude	Page
1. Land use (Rank alternative routes in terms of amount of conflict with present and planned land use)									
2. Property values (Rank alternative routes in terms of total loss in property values)									
3. Multiple use (Rank alternative routes in terms of envisioned multiple use of land preempted by rights-of-way)									
4. Length of new rights-of-way required									
5. Number and length of new access and service roads required									
6. Number of major road crossings in vicinity of intersection or interchanges									
7. Number of major waterway and railroad crossings									
8. Number of crest, ridge, or other high point crossings									
9. Number of "long views" or transmission lines perpendicular to highways and waterways									

Table 5 (concluded)

ENVIRONMENTAL COSTS	UNITS	ALTERNATIVES A Magnitude	A Page	B Magnitude	B Page	C Magnitude	C Page	D Magnitude	D Page
10. Length of above transmission line in or through the following visually sensitive areas.									
10.1 Natural water body shoreline									
10.2 Marshland									
10.3 Wildlife refuges									
10.4 Parks									
10.5 National and state monuments									
10.6 Scenic areas									
10.7 Recreation areas									
10.8 Historic areas									
10.9 Residential areas									
10.10 National forests and/or heavily timbered areas									
10.11 Shelter belts									
10.12 Steep slopes									
10.13 Wilderness areas									
10.14 to [Other sensitive or critical areas, 10.20 specify]									
10.21 Total length through sensitive areas (sum 10.1-10.20)									
10.22 Total net length through sensitive areas (sum 10.1-10.20 eliminate duplication)									

Table 6 COST DESCRIPTION OF PROPOSED FACILITY AND TRANSMISSION HOOK-UP

(All monetized costs expressed in terms of their present and annualized values)

Generating Cost	Present Worth Annualized			
Transmission and Hook-up Cost	Present Worth Annualized			
Environmental Costs (see Table 3)		UNITS	MAGNITUDE	PAGE
1. NATURAL SURFACE WATER BODY				
1.1 Impingement or entrapment by cooling water intake structure				
1.1.1 Fish				
1.2 Passage through or retention in cooling systems				
1.2.1 Phytoplankton and zooplankton				
1.2.2 Fish				
1.3 Discharge area and thermal plume				
1.3.1 Water quality, excess heat				
1.3.2 Water quality, oxygen availability				
1.3.3 Fish, nonmigratory				
1.3.4 Fish, migratory				
1.3.5 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)				
1.4 Chemical effluents				
1.4.1 Water quality, chemical				
1.4.2 Fish				
1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)				
1.4.4 People				
1.5 Radionuclides discharged to water body				
1.5.1 Aquatic organisms				
1.5.2 People, external				
1.5.3 People, ingestion				
1.6 Consumptive use				
1.6.1 People				
1.6.2 Agriculture				
1.6.3 Industry				
1.7 Plant construction (including site preparation)				
1.7.1 Water quality, physical				
1.7.2 Water quality, chemical				
1.8 Other impacts				
1.9 Combined or interactive effects				
1.10 Net effect				

Table 6 (continued

Environmental Costs (see Table 3)	UNITS	MAGNITUDE	PAGE
2. GROUND WATER			
2.1 Raising/lowering of ground water levels			
2.1.1 People			
2.1.2 Plants			
2.2 Chemical contamination of ground water (excluding salt)			
2.2.1 People			
2.2.2 Plants			
2.3 Radionuclide contamination of ground water			
2.3.1 People			
2.3.2 Plants and animals			
2.4 Other impacts on ground water			
3. AIR			
3.1 Fogging and icing (caused by evaporation and drift			
3.1.1 Ground transportation			
3.1.2 Air transportation			
3.1.3 Water transportation			
3.1.4 Plants			
3.2 Chemical discharge to ambient air			
3.2.1 Air quality, chemical			
3.2.2 Air quality, odor			
3.3 Radionuclides discharged to ambient air and direct radiation from radioactive materials			
3.3.1 People, external			
3.3.2 People, ingestion			
3.3.3 Plants and animals			
3.4 Other impacts on air			

Table 6 (concluded)

Environmental Costs (see Table 3)	UNITS	MAGNITUDE	PAGE
4. LAND			
4.1 Site selection			
4.1.1 Land, amount			
4.2 Construction activities (including site preparation)			
4.2.1 People (amenities)			
4.2.2 People (accessibility of historical sites)			
4.2.3 People (accessibility of archeological sites)			
4.2.4 Wildlife			
4.2.5 Land			
4.3 Plant operation			
4.3.1 People (amenities)			
4.3.2 People (aesthetics)			
4.3.3 Wildlife			
4.3.4 Land, flood control			
4.4 Salts discharged from cooling towers			
4.4.1 People			
4.4.2 Plants and animals			
4.4.3 Property resources			
4.5 Transmission route selection			
4.5.1 Land, amount			
4.5.2 Land use and land value			
4.5.3 People (aesthetics)			
4.6 Transmission facilities construction			
4.6.1 Land adjacent to right-of-way			
4.6.2 Land, erosion			
4.6.3 Wildlife			
4.6.4 Flora			
4.7 Transmission line operation			
4.7.1 Land use			
4.7.2 Wildlife			
4.8 Other land impacts			
4.9 Combined or interactive effects			
4.10 Net effects			

APPENDICES

Appendix 1 Questionnaire for Eliciting Data for Radioactive Source-Term Calculation

Pressurized Water Reactors

Basic Data for Source Term Calculation

1. Reactor power (MWt) at which impact is to be analyzed.
2. Weight of U loaded (first loading and equilibrium cycle).
3. Isotopic ratio in fresh fuel (first loading and equilibrium cycle).
4. Expected percentage of leaking fuel.
5. Excape rate coefficients used (or reference).
6. Plant capacity factor (%).
7. Number of steam generators.
8. Type of steam generators (recirculating, once-through).
9. Mass of primary coolant in system total (lb) and mass of primary coolant in reactor (lb).
10. Primary coolant flow rate (lb/hr).
11. Mass of steam and mass of liquid in each generator (lb).
12. Total active mass of secondary coolant (lb) (excluding condensate storage tanks).
13. Steam generagor operating conditions (temperature °F, pressure psi, flow rate, lb/hr).
14. The number, type and size of condensate demineralizer and total flow rate (lb/hr).
15. What is the containment free volume (ft^3)?
16. What is the expected leak rate of primary coolant (lb/hr) to the containment atmosphere?
17. Is there an internal air cleanup system for iodine in the containment? If so, what volume per unit time is circulated through it? What decontamination factor is expected? How long will the system be operated prior to purging?
18. How often is the containment purged? Is it filtered prior to release? Type of iodine clean-up system provided? What decontamination factor is expected?
19. Give the total expected annual average letdown rate (lb/hr) during power operation.
    a. What fraction of the letdown is returned to the primary system? How is it treated? What are the expected decontamination factors for removal of principal isotopes?
    b. How is the Li and Cs normally controlled?
    c. What fraction of this goes to boron control system? How is this treated, demineralization, evaporation, filtration?
    d. Is plant design for load follow or base load? What fraction of the letdown stream is diverted to the radwaste system for boron control. How is this treated (demineralization, evaporation, filtration, etc.) and what fraction will be discharged from the plant?
20. What fraction of the letdown stream is stripped c noble gases and iodines? How are these gas collected? What decay do they receive prior to release? Indicate stripping fraction.
21. How are the noble gases and iodines stripped from that portion of the letdown stream which is sent to the boron control system? How are these gases collected? What decay do they receive prior to release?
22. Are the releases from the gaseous waste storage tanks passed through a charcoal absorber? What decontamination factor is expected?
23. How frequently is the system shut down and degassed and by what method? How many volumes of the primary coolant system are degassed in this way each year? What fraction of the gases present are removed? What fraction of other principal nuclides are removed, and by what means? What decay time is provided?
24. Are there any other methods of degassing (i.e., through pressurizer, etc.)? If so describe. How is it treated?
25. What is the expected leak rate of primary coolant (lb/hr) to the secondary system?
26. What is the expected rate of steam generator blowdown (lb/hr) during power operation with the expected leak rate noted in Question No. 25? Where are the gases from the blowdown vent discharged? Are there charcoal absorbers and/or condensers on the blowdown tank vent? If so, what decontamination factor is expected? How will the blowdown liquid be treated?
27. What is the expected leak rate of steam (lb/hr) to the turbine building? What is the ventilation air flow (cfm) through the turbine building? Where is it discharged? Is the air filtered or treated before discharge? If so, provide expected performance.
28. What is the flow rate (cfm) of gaseous effluent from the main condenser ejector? What treatment is provided? Where is it released?
29. What is the origin of the steam used in the gland seals (i.e., is it primary steam, condensate, or demineralized water from a separate source, etc.)? How is the effluent steam from the gland seals treated and disposed of?
30. What is the expected leak rate of primary coolant (lb/hr) to the auxiliary building? What is the ventilation air flow through the auxiliary building (cfm)? Where is it discharged? Is the air filtered or otherwise treated before discharge? If so, provide expected performance.
31. Provide average gallons/day and μCi/cc prior to treatment for following categories of liquid waste effluents. Use currently observed data in the industry where different from the SAR or Environmental Report (indicate which is used).

a. High-level wastes (for example, primary coolant let down, "clean" or low-conductivity waste, equipment drains and deaerated wastes);
b. "Dirty" wastes (for example, floor drain wastes, high-conductivity wastes, aerated wastes, and laboratory wastes);
c. Laundry, decontamination, and wash-down wastes;
d. Steam generator blowdown–give average flow rate and maximum short-term flows and their duration;
e. Drains from turbine building;
f. Frequency of regenerating condensate demineralizers and expected volume of regenerant solutions.

For the above-listed wastes (a-f) provide:
1. Number and capacity of collector tanks.
2. Fraction of water to be recycled and factors controlling decision.
3. Treatment steps–include number, capacity, and process decontamination factor for each principal nuclide for each step. If step is optional, state factors controlling decision.
4. Decay time from primary loop to discharge.

. Dilution flow rate for liquid effluents, minimum and normal gpm and total gallons per year.
. How is waste concentrate (filter cake, demineralizer resin, evaporator bottoms) handled? Give total volume, weight and curies per day or year.
. Include the expected annual volume of dry waste and curie content of each drum.
. For demineralizer regenerants, provide: (a) time between regeneration; (b) treatment of regenerants; (c) regenerant volumes; and (d) fraction discharged.
. Provide a process and instrumentation flow diagram for the gaseous and liquid radwaste systems.

Boiling water reactors

sic Data for Source Term Calculation

. Reactor power (MWt) and plant capacity factor (%) at which impact is to be analyzed.
. Weight of U loaded (first loading and equilibrium cycle).
. Isotopic ratio in fresh fuel (first loading and equilibrium cycle).
. Expected offgas rate after 30 minutes delay.
. Escape rate coefficients used (or reference).
. Primary coolant in system (lb).
   a. Mass of primary coolant in reactor; mass water, mass steam (lb).
   b. Mass of primary coolant in recirculating system (lb).
   c. Fraction of primary coolant in main condenser.
. Steam conditions at turbine (temp °F, press. psi, flow lb/hr).
. Normal recirculation flow rate (lb/hr).
9. Normal clean-up system flow rate (lb/hr). What type of resins are used? What decontamination factors are expected for each principal nuclide? What is the frequency of regeneration and volume of regenerants?
10. Describe and provide the expected performance of the expanded gaseous radwaste treatment system from the main condenser air ejector. Give the expected air inleakage. Is the condenser ejector one stage or two stage? Where is it discharged? How many condenser shells? (If applicable–Pounds of charcoal and operating temperature of.)
11. What is the expected leak rate of primary coolant (lb/hr) to the dry well? How frequently is the dry well purged? What treatment is given to this purge and where is it released?
12. What is the expected leak rate of primary coolant (lb/hr) to the reactor building? What is the ventilation air flow (cfm) through the reactor building? Where is it discharged? Is the air filtered or otherwise treated before discharge? If so provide expected performance.
13. What is the expected leak rate of steam (lb/hr) to the turbine building? What is the ventilation air flow (cfm) through the turbine building? Where is it discharged? Is the air filtered or treated before discharge? If so, provide expected performance.
14. Describe the treatment of the exhaust stream from the turbine seal glands.
    a. What is the origin of the steam used in the gland seals? (i.e., is it primary steam condensate, or demineralized water from a separate source, etc.?)
    b. How is the waste stream from the gland seals treated and disposed of?
    c. Indicate how often the mechanical vacuum will be operated and the expected range of activity released.
15. Provide average gallons/day and μCi/cc prior to treatment for the following categories of liquid waste. Use currently observed data in the industry where different from the SAR or Environmental Report (indicate which is used).
    a. High-purity wastes (for example, "clean" or low-conductivity waste and equipment drains). Give range of activity expected.
    b. "Dirty" wastes (for example, floor drain wastes, high-conductivity wastes, and laboratory wastes). Give range of activity expected.
    c. Chemical wastes. Give range of activity expected.
    d. Laundry, decontamination, and wash-down wastes. Give range of activity expected.

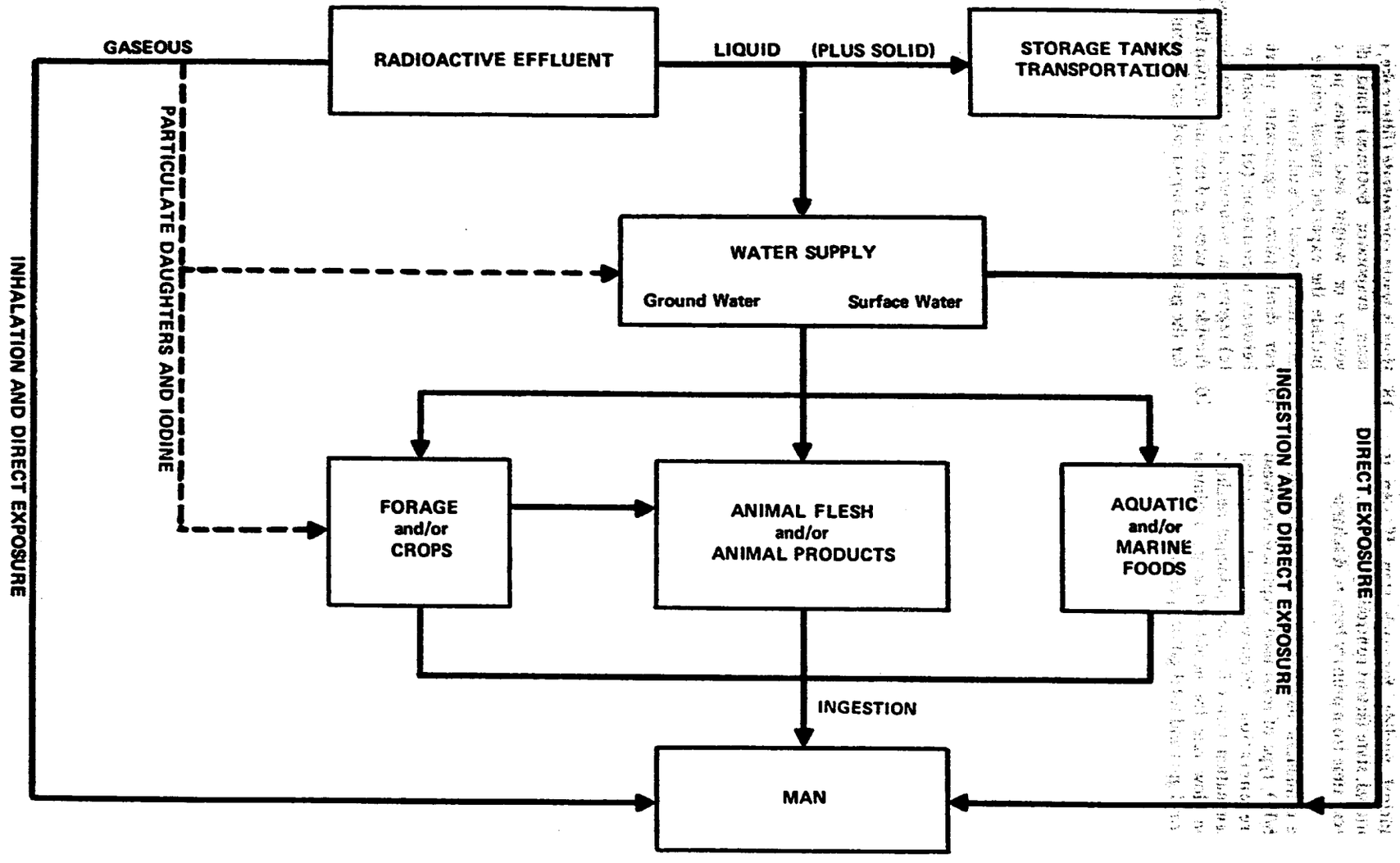
For the above-listed wastes (a-d), provide:
1. Number and capacity of collector tanks.
2. Fraction of water to be recycled or factors controlling decision.
3. Treatment steps–include number, capacity, and process decontamination factor for each

principal nuclide for each step. If step is optional, state factors controlling decision.

4. Decay time from primary loop to discharge.

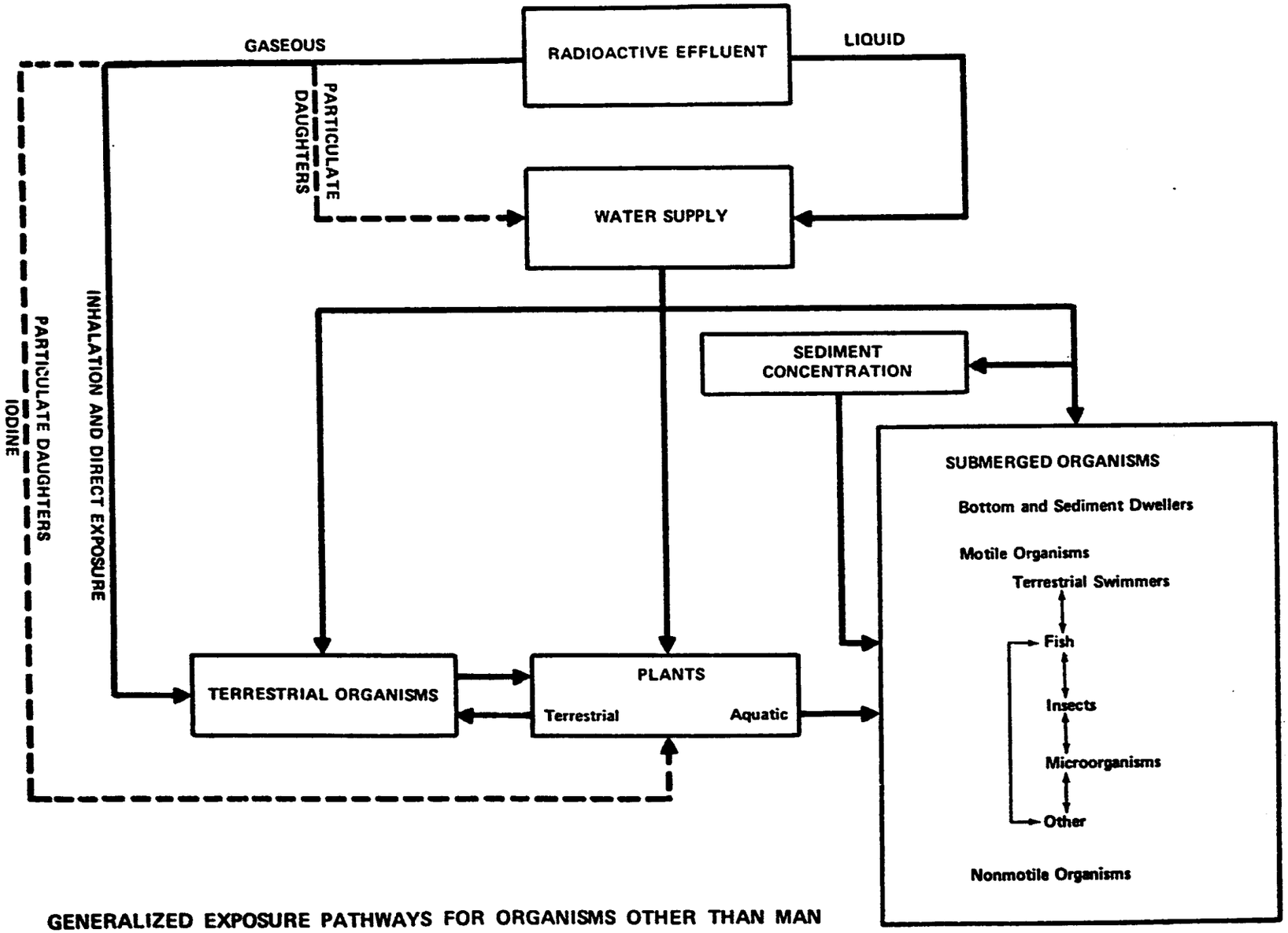
16. For the condensate demineralizers provide the flow rate (lb/hr), type of resin used, expected backwash and regeneration frequency, and expected decontamination factor for each principal nuclide.
17. Dilution flow rate for liquid effluents, minimum and normal gpm and total gallons per year.
18. How is waste concentrate (filter cake, demineralizer resin, evaporator bottoms) handled? Give total volume or weight and curies per day or year. Include the expected annual volume of dry waste and curie content of each drum.
19. For demineralizer regenerants, provide: (a) time between regeneration; (b) treatment of regenerants; (c) regenerant volumes; and (d) fraction discharged.
20. Provide a process and instrumentation flow diagram for the gaseous and liquid radwaste systems.

Appendix 2. EXAMPLE OF CHARTS SHOWING RADIATION EXPOSURE PATHWAYS



GENERALIZED EXPOSURE PATHWAYS TO MAN

Appendix 2 (Concluded)



GENERALIZED EXPOSURE PATHWAYS FOR ORGANISMS OTHER THAN MAN

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	PAGE
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PAGE

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SUBJECT INDEX

Agricultural wastes, 2-201, 2-231, 2-257, 2-277
Air diffusion, 3-95
Air dispersion, 3-117
Air pollution, 3-1
Air pollution control, 3-1, 3-95, 3-103, 3-117
Animal wastes (see Livestock wastes)

Benefits and costs (see Environmental economics)
Bibliographies, 1-60 (Environmental economics), 2-162 (Solid waste), 2-306 (Stream surveys), 2-320 (Industrial solid wastes), 3-92 (Air pollution and meteorology), 4-12 and 4-85 (Toxicology), 4-51 (Radiation), 4-155 (Industrial wastes), 4-225 (Brine wastes), 5-261 (Information exchange)

Combustion, 3-103
Composting, 2-109
Copper mining, 4-144
Costs and benefits (see Environmental economics)

Economic development, 1-1, 1-257
Economics (see Environmental economics)
Energy, 1-265, 5-1, 5-107, 5-215
Environmental economics, 1-1, 1-104, 1-169
Environmental effects, 1-265, 4-15, 4-87, 4-110, 5-12, 5-53, 5-243
Environmental impact, 1-265, 4-15, 4-87, 4-110, 5-12, 5-53, 5-95, 5-107, 5-119, 5-129, 5-243
Environmental management, 1-1, 5-139
Environmental publications, 5-261

Food processing wastes, 4-157, 4-227

Glossary, 2-187, 5-281
Growth, 1-169, 1-193, 5-143, 5-187, 5-215

Incineration, 2-96
Industrial hygiene, 4-57, 4-151, 4-237
Industrial wastewater, 2-13, 2-31, 2-201, 2-231, 2-257, 2-277, 4-155, 4-157, 4-171, 4-189, 4-207, 4-219, 4-225, 4-227
International Bank for Reconstruction and Development, 4-87

Land use planning, 1-71, 1-211, 4-15
Landfill (see Sanitary landfill)
Livestock wastes, 2-201, 2-231, 2-257, 2-277, 4-171

Marine disposal, 2-130, 2-157
Metal finishing wastes, 4-53, 4-207
Mining, 4-110, 4-134, 5-119, 5-129, 5-187

Nuclear power, 1-265

Occupational health (see Industrial hygiene)
Ocean disposal, 2-131, 2-157
Ocean outfalls, 2-189

Paper mill wastes, 4-142, 4-189
Planning, air pollution, 3-1
Planning, land use, 1-71, 1-211
Planning, water, 2-321, 2-333
Plating wastes, 2-24, 4-53, 4-207
Population, 5-169
Pulp and paper wastes, 4-142, 4-189

Quality of life, 1-169, 5-139, 5-143, 5-215

Radioactivity, 4-31

Sampling, 2-297
Sanitary landfill, 2-49
Solid wastes, 2-47, 2-311
Standards, 1-141, 2-307, 4-245
Steel manufacture, 4-139

Toxicology, 4-1, 4-67

Wastewater disposal, 2-31
Wastewater flows, 2-1, 2-297
Wastewater treatment, 2-13, 2-163
Water supply, 2-295, 2-307, 2-331
Worker environment (see Industrial hygiene)
World Bank, 4-87