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AN INFORMATION SYSTEM FOR IMPROVING THE EVALUATION OF NONMARKETED OUTPUTS

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**INSTITUTE
FOR
WATER RESOURCES**


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INSTITUTE FOR WATER RESOURCES

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R. H. GROVES
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AN INFORMATION SYSTEM
FOR IMPROVING THE EVALUATION OF
NONMARKETED OUTPUTS

A Report by the
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FOREWORD

Purpose

This report is written for the practitioner in water resources planning who is searching for workable methods to evaluate those outputs of water resources investments which can not be adequately evaluated in dollar terms.

Recommendations

The report recommends an information system which provides:

- 1) The establishment of a foundation for systematically and objectively identifying and evaluating environmental and social impacts and for determining environmental and social objectives;
- 2) The development of a permanent structure for receiving, holding, and releasing information which should be considered in assessing environmental problems and potentials;
- 3) The formation of a regional context in which investment consequences can be evaluated, so that anticipated developments can be viewed against the suitability and capability of a regional environment to accommodate change induced by a project.

Assessment

In developing the Information System the report compares, evaluates, and synthesizes several concepts aimed toward the evaluation of nonmarket outputs and places the synthesized concepts within the context of the planning process and organizational constraints of the Corps of Engineers. The research effort does not represent an exhaustive search for all value concepts in the literature; rather, the effort focuses on only one grouping of concepts which appear to have promise in light of environmental, public participation, and other concepts under consideration by the Institute for Water Resources. The problem of measuring environmental and social impacts, as opposed to evaluating them, is not taken up; the breadth and difficulty of the "measurement problem" is sufficient to merit separate treatment. While most of the concepts discussed in this study are familiar to the student of public investment theory, the field planner should find the discussion useful; the various concepts discussed are simply stated and related directly to the planning function.

In addition to contributing to the improved evaluation of nonmarket outputs of water resources projects, use of the recommended Information System would make it possible to monitor current decision-making and to systematically record past decisions and supporting information. The system would thereby lead, over a period of time, to the development of a substantial base of consistent data on which internal assessments could be made to improve decision making, and to reduce the time and cost of preauthorization planning. Implementation of the system would also provide a body of relevant information which could be examined in an effort to develop quantitative measures of environmental and social impacts.

Status

The information system has not been completely developed herein. The objective is to articulate the conceptual framework in broad terms but in sufficient detail to provide for an evaluation of its acceptability and desirability without waiting for perfection. Some of the concepts and ideas expressed herein are innovative and depart from present practice, including suggestions for modifications of existing organizational responsibilities. The work is exploratory in nature and of course the conclusions, opinions, and other statements are those of the author and not necessarily those of the Corps of Engineers. The next step in determining the efficacy of the proposals will be to arrange for some trial field applications.

TABLE OF CONTENTS

	Page
FOREWORD	iii
I. INTRODUCTION	1
1. Purpose	1
2. The Problem	1
3. Report Format	2
II. CONTEXT OF THE PROBLEM	3
1. Benefit-Cost Analysis	3
2. Public Objectives	4
a. The provision of Public Goods	5
b. The Redistribution of Income	5
c. The Elimination of Spillover Effects	5
3. Output Classification	6
a. Marketed Outputs	6
b. Nonmarketed Outputs	6
4. Multiple Objectives	7
III. EVALUATION OF NONCOMMENSURATE OUTPUTS	9
1. Inferred Market Evaluation	9
2. Noncommensurate Output Evaluation	11
3. Assessment and Synthesis of Noncommensurate Output Evaluation Concepts	15
a. Assessment	15
b. Synthesis	17
(1) The Conception Phase	17
(2) The Public Participation Phase	18
4. The Planning Framework	19
a. Modification of the Planning Framework	20
b. Implementation of the Conceptual Framework	22

IV.	AN INFORMATION SYSTEM TO SUPPORT THE EVALUATION OF NONMARKETED OUTPUTS	25
1.	Scope	25
2.	Objective	25
3.	Goals	26
4.	Constraints	27
	a. Planner's Attitudes	27
	(1) Sample Survey	27
	b. Professional Skills	28
5.	Organization	28
6.	The Information System	30
	a. Judgment - Free Data Bank	30
	b. Regional Environmental Profile	30
	c. Information Displays	31
	(1) Impact Display	31
	(2) Public Participation Display	33
7.	Operation of the Information System	34
	a. Regional Environmental Profile	36
	b. Preparation of Regional Environmental Profile	37
	c. Data Bank	38
	d. Project Formulation	38
	APPENDIX A - JUDGMENT - FREE DATA BANK	40
	BIBLIOGRAPHY	44

PART I
INTRODUCTION

1. Purpose. This paper develops and recommends: (a) an approach to evaluating noncommensurate* benefits; (b) a planning framework to support the effective utilization of the recommended evaluation approach; and (c) an information system to inform and monitor decision making within the recommended planning framework.

2. The Problem. Water resource projects produce benefits which contribute to many different private and public objectives. If these benefits could all be valued in terms of some common unit of account, such as the dollar, a single criterion could serve to guide investment decision making. Unfortunately, the fields of public investment theory and practice do not provide us with such a unit of value. Planners in the Corps of Engineers must, nonetheless, take into account the varied contributions of water resource projects toward multiple public objectives. The planners must consider how the problem of evaluating the noncommensurate outputs of water resources investments should be approached. The following discussion attempts to address this problem by outlining a suitable approach for use by the Corps of Engineers, and similar resource development agents. While the emphasis of the study is on the evaluation of nonmarketed** "environmental" outputs, the broad aim is to develop a framework which meets the requirements of the Corps of Engineers to evaluate all types of nonmarket benefits.

* Noncommensurate: not measurable by the same standard or measure.

** Nonmarketed: not exchanged in the market.

3. Report Format.

a. Part II of this essay provides a theoretical and technical perspective necessary to grasp an overall understanding of nonmarket evaluation problems. Interrelated concepts, methods and issues are explained and a nomenclature is provided for separating and discussing the measurable nonmarketed component of benefits from other components.

b. Part III compares and assesses the worth of selected approaches to the evaluation of nonmarketed outputs and makes recommendations for a useful approach within a water-oriented planning framework.

c. Part IV develops and recommends a conceptual outline of an information system which supports the evaluation of noncommensurate outputs discussed in Parts II and III. The design of the information system is drawn directly from conclusions regarding significant internal and external factors which constrain planning within the Corps.

PART II

CONTEXT OF THE PROBLEM

1. Benefit-Cost Analysis. In the mid-1930's, when benefit-cost analysis was first extensively used in making decisions on water resources investment, national economic efficiency was widely accepted as the dominant federal objective. National income benefits for some years now have been compared with costs to provide a basis for evaluating investments and, until recently, only token recognition was given to other effects in the analysis. With national income serving as the sole proxy, a benefit-cost ratio in excess of 1 indicates that the value of the investment exceeds the cost of the project in terms of societal advantage.

In today's world, acceptance of the belief that esthetic, distributional, health, recreational, and other consequences of investments should be emphasized equally with national income effects is becoming widespread [2].* Progress toward recognition of the above objectives in applied water resources investment analysis has been substantial in recent years. It is reasonable to anticipate that, within the next few years, a framework which formally recognizes several broad categories of objectives will be utilized in most federal water resources investment analyses undertaken in this country.

* Bracketed numerals refer to items listed in the bibliography.

A current proposal by the Water Resources Council calls for explicitly relating all benefits and costs to distinctly separate objectives relevant to each investment decision. Within the above presentation, most significant investment consequences would fall under one of the following four categories: national economic development; environmental quality; social well-being; and regional development [11].

Regardless of the nature of the eventual formal framework adopted, recognition of the multiplicity of objectives served by water resources investments makes the determination of benefits and costs extremely difficult, particularly when it is not possible to state all benefits in terms of a common unit of account. Of the several kinds of outputs produced by public investment some may be expressible in dollars, and others only in physical or social aspects. The evaluation of outputs within the organization of planning by the Corps of Engineers is the focus of this paper. In order to deal clearly with this subject, principal concepts and terms central to the discussion of the non-commensurate benefit evaluation problem are defined below.

2. Public Objectives. Carlson has pointed out that the measurement of benefits in the public sector are difficult because many of the objectives of the federal government are not required by the private, or business, sector in planning. [1] Of the broad public sector objectives listed by Carlson, three are particularly relevant to the evaluation of water resources investments: (a) providing public goods; (b) redistributing income; and (c) eliminating spillovers. These objectives can be briefly described.

a. The Provision of Public Goods. The distinctive feature of a "public good" is that it can be consumed by more than one person at the same time at no extra expense; and it may actually cost something to exclude potential consumers. The producer of a "public good" is unable to require the users to pay him for the good.[8] Consequently, there is no incentive for private enterprise to make investments in "public goods" such as scenic beauty or national defense.

b. The Redistribution of Income. Another broad objective of our society is the transfer of funds (in the form of cash, in-kind assistance, or provision of future cash or in-kind assistance) to particular groups that society thinks are particularly worthy of need of assistance; e.g., the Appalachian poor, or big city ghetto dwellers.

c. The Elimination of Spillover Effects. Divergencies between costs and gains from the standpoint of the individual decision maker and the costs and gains of others are often termed "spillovers," or "externalities." If, for example, the costs of stream pollution did not result in cost to the polluter, these costs would probably not be taken into account in his decision making. Therefore, the market price would not reflect the actual costs to society.[1] Much of the legislation concerned with the quality of the environment attempts to correct this inequality, by providing a mechanism whereby the person who causes damage to others (e.g., the stream polluter) compensates those persons for the damage he causes or is limited in the extent of damage he may cause.

3. Output Classification. The classification outlined and explained below separates various types of marketed and non-marketed outputs.[3]

Output Classification

1. Marketed:

- a. No spillovers
- b. Spillovers

2. Not Marketed:

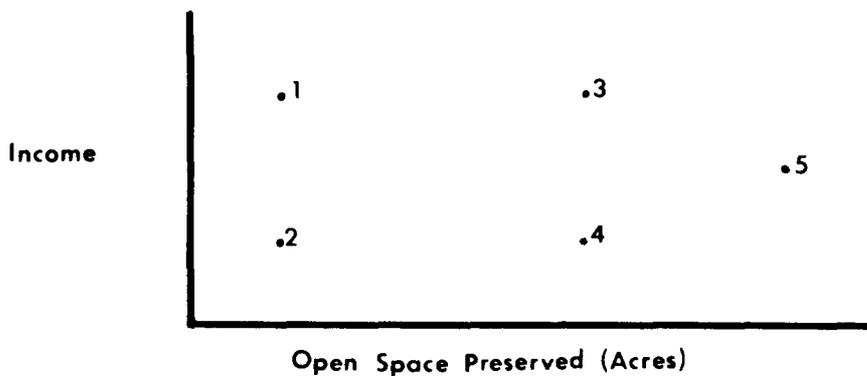
- a. Divisible and measurable
- b. Public goods and measurable
- c. Public goods and nonmeasurable

a. Marketed Outputs: Outputs can be classified according to several attributes. Some outputs are sold by the government; markets are used to allocate these outputs to those individuals with the highest willingness to pay, or to those persons who place the highest evaluation on them. If there are no spillover effects, the market price is the value of that output; e.g., municipal water. Where there are spillovers, the price is not equal to the worth, and the external effects must be taken into account in determining this worth; e.g., treatment services for industrial wastes.

b. Nonmarketed Outputs: Of the outputs not able to be assigned a price in the market, some are divisible and others are nondivisible. Outputs are divisible if one person can have more without simultaneously increasing the amounts going to other individuals, e.g., irrigation water. On the other hand, public goods (nondivisible outputs) are peculiar in that one person's consumption does not affect the amount available for another's consumption, e.g., scenic beauty.

Nonmarketed outputs can be further divided into measurable-nonmeasurable classes. The redistribution of income is an example of a public good which is measurable, as opposed to national defense, a public good which is nonmeasurable. Outdoor recreation is an example of the class of nonmarket outputs which is divisible and measurable.

4. Multiple Objectives. Multiobjectives of programs cannot be combined into a single measure of worth, and many individual projects produce outputs which are impossible to combine into a single measure of project worth. [4] The conceptual difficulty that arises when trying to reconcile separate benefit measures can be simply illustrated. Consider a water resources program in which individual projects contribute to each of three objectives: (a) increased national income; (b) regional job-creation; and (c) the preservation of open space. For each of these objectives there is a reasonable benefit measure: (a) dollar increases in national income; (b) number of jobs created, regardless of the income created; and (c) preservation of a number of acres of open space of a particular quality. The diagram below shows a project array with two of the three outputs exemplified.



If all of the five alternatives depicted in the diagram cannot be funded, it is clear that 1 is preferred to 2 (1 gives more income and the same amount of open space). It is also clear that 3 is preferred to 1 and 4 for similar reasons. But how should the choice between 1 and 4, and 3 and 5 be made? Several approaches which can be applied to this problem are discussed in Part III.

The central aspects of choosing among alternatives when faced with multiple objectives are how to define an appropriate measure of each objective and how to judge among objectives. The measure of each objective must be weighted by the Congress and other decision makers if a complete and correct decision is to be expected. If objectives are actually multi-dimensional and not immediately comparable, some solution to the weighting problem is implicit or explicit in any choice, and the solution decided upon reflects a specific value judgment. It will be shown in Part III that the choice of weights is sometimes treated as a prior decision, be it constraint or assumption which controls public expenditure decisions, and sometimes a concurrent or joint decision--as an inseparable part of the process of choice.

PART III

EVALUATION OF NONCOMMENSURATE OUTPUTS

1. Inferred Market Evaluation. All of the types of outputs classified in Part II have value, if by value we mean a willingness by individuals to pay some amount of money for these outputs. In the private sector of a market economy there is a method for expressing a willingness to pay. Thus, the problem of evaluating goods or activities in the open market is solved by exchanges, where money enters on one side of the exchange. Wherever money is used, we can form a ratio of the amount of the good to the amount of money; the ratio is the price and this can be quoted for all goods and activities. Where there are no spillover effects, value or willingness to pay is equal to the market price.

However, only some of the things we value as a society are exchanged in the market place. Some things could be so exchanged but are distributed through political institutions. Other things could not be distributed through market institutions even if we wished to because they cannot be appropriated and withheld from individual consumers unwilling to pay for them. None of these non-market valued goods and services enters into the national income objective and the benefit-cost ratio unless we impute a monetary value to it, as if it were in fact marketed.[7]

Valuation of goods in private markets is based on the demand for specific outputs. Demand is determined by individual preference and income. It is usually accepted that individual preference should also

govern the values placed on things produced by the public sector as well. Since direct market expression of individuals' willingness to pay for benefits is not always possible, valuation must be based on indirect evidence. Margolis describes three indirect procedures which are used to assign a value to a public output:[8]

a. The most common technique used to evaluate public output is to consider a public project as an intermediate good. The value of the marginal product of the good in further production can then be estimated by determining how much the availability of the public output increases the producer's income. For example, productivity studies of irrigated farms are used to estimate the value of the produce of an incremental acre-foot of water; this value is then given to the water in agricultural production. It is assumed that the farmer would be willing to pay this amount as a price for the water and therefore the marginal product is identified as the "imputed market value," or "shadow price" of the water.

b. A second indirect technique that is also commonly used to estimate the amount individuals are willing to pay is based upon the added costs they would have incurred if the public service were not supplied. This approach is most commonly adopted in the fields of transportation and power. Generally it is assumed that there is an inelastic demand for the output and therefore the requirement of transportation or energy would have to be met by private effort at a higher cost. The major source of savings are shown by comparing the public service costs with the alternative private carrier costs in the case of transportation and private generation of energy in the case of power.

c. The third major technique for assigning a monetary value to public output is to estimate directly the cost to the user by referring to market information. In many cases there are closely related private substitutes for public production. For example, there is usually a private recreation market; the extensive study of this market may provide the needed information for public recreation pricing.

2. Noncommensurate Output Evaluation. The dollar criteria for measuring benefits is relevant only when a private market for goods and services does or could exist, or where reasonable proxies for private markets or "shadow prices" can be calculated. When part of the mix of benefits of water resource investment cannot be valued in dollar terms, the efficiency criterion is inadequate as a decision making tool since some of the benefits are not captured by that criterion. Several approaches have been developed for evaluating investments which produce both dollar-valued and non-dollar-valued benefits.[3] These approaches are briefly discussed below.

The Eckstein Approach. Otto Eckstein has recommended that those formulating alternative designs interpret the desires of the policy framers and express them in an analytical form as an objective function and then establish decision models which reveal explicitly what actions will maximize the achievement of specified objectives. In order to clearly understand the consequences of the criteria for design and selection of projects, it is necessary to express the preferences of the policy framers in explicit weights or values of one form of benefit in terms of the other. The usefulness to society of non-dollar-valued

benefits are approximated by attaching a relative monetary weight to each unit of unvalued benefits. If these consequences are thought to be desirable, then the same set of weights or objective function can be used to achieve a consistent set of decisions concerning all proposed projects. The object of project design is to maximize the sum of valued benefits plus the assigned monetary value of unvalued benefits.

The Marglin Approach. Marglin has proposed that a method be formulated to establish some minimum level of one benefit and that the project be designed to maximize the other benefits subject to constraints on the estimation of non-dollar evaluated benefits. The choice of the minimum value for the constrained benefit determines the resulting relative valuation of the benefits. There is no established rule for deciding which variables are to be constrained and which are to be maximized in the analysis. Any choice of an alternative implies a certain relative valuation or trade-off ratio between valued and unvalued benefits.

The McKean Approach. McKean has suggested that decision makers be provided with a schedule showing the net money valued benefits as well as descriptions of the other benefits (and costs, if appropriate) for each alternative project design that is analyzed. The decision maker selects that alternative which conforms best to his subjective evaluations or his interpretation of society's preferences for or valuation of money valued benefits vs. other benefits. Some of the alternative designs may be clearly inferior, but the choice among other designs cannot be made without some knowledge of the relative desirability of market-valued and nonmarket-valued benefits. McKean's suggestion is

to rely upon the decision maker to make the choice himself. Whichever alternative is chosen will provide a clue as to the relative value of dollar-valued and nondollar-valued benefits which are held by the decision maker.

The Lord Approach. Lord introduces a subtle but important modification to the McKean approach. Lord's approach is premised on the belief that: 1) investment impacts should be explicitly identified with project-affected user groups as a formal component of the investment analysis; and 2) information describing investment impacts should be made available during the investment formulation process to facilitate political bargaining before investment recommendations are made to the Congress.[7]

Under the Lord approach, investment contributions to various objectives are defined openly and directly as to the results to specific groups which are affected by projects and programs. User groups are given an opportunity to express their interests in connection with proposed alternatives, and based on these expressions, alternative(s) and/or the range of alternatives may be modified. Implicit in any design or locational modification in response to these expressions is the relative value which the public places upon various aspects of the modified alternative(s). Investment impacts are related to user groups via the Public Participation Matrix* illustrated below.

* I have taken the liberty to label this matrix the Public Participation Matrix for purposes of exposition; it will be referred to frequently in later parts of the paper. The concept of the Public Participation Display first came to the attention of IWR in a paper presented by Dr. Lord at the Water Resources Council Hearings in Wash., D.C., Sep 10, 69. In April 1970, a University of Wisconsin team, under Dr. Lord's direction, introduced this concept in a case study of the Mt. Home Division of the Southwest Idaho Water Development Project.

PUBLIC PARTICIPATION MATRIX

Interests Affected Impacts	Recreation- tionists	Conserva- tionists	Economic Interests	Etc.
Environmental a. Ecological b. Visual c. Human-Cul - tural d. etc. Developmental a. b. Social a. b.				

3. Assessment and Synthesis of Noncommensurate Output Evaluation Concepts.

a. Assessment. The applicability and usefulness of each of the four approaches described above varies with the particular set of circumstances which surround the investment decision. However, from a partial review of the literature, it appears that, of the four approaches described above, only the Eckstein approach cannot presently be applied toward improvement of noncommensurate benefit evaluations. In Eckstein's approach, society's relative preferences for nondollar-valued benefits can be approximated by attaching a relative monetary weight to each unit of unvalued benefits. Then, the object of project design is to maximize the sum of valued benefits plus the assigned monetary value of unvalued benefits. Several arguments which discourage the application of the Eckstein approach can be briefly summarized:

(1) The nature of the democratic process means that there are many participants in the decision making. The weights established by the project engineer may be different for each of several objectives than his department head; the weights of the department head may be different than the President when the President makes his recommendations to the Congress; and the recommendation of each subcommittee and committee of the Congress will likely reflect differing weights. It would be better to allow decision makers to weigh each objective than to have them aggregated and weighed in one arbitrary way.[1]

(2) An important justification for separating measures of national income objectives from other estimated beneficial objectives is that the latter are less clearly defined. No consensus has been reached regarding

national goals and objectives, and the public's preferences may frequently differ from the preferences indicated by the quantitative measures of benefit chosen by a particular set of planners.

(3) Even those who accept the concept of selecting explicit weights prior to a choice among alternatives frequently object to the manner in which weights are to be determined. Freeman has shown that we are not likely to be able to infer weighting functions from observed Congressional choices, both because we cannot be sure that the same weighting function was used to make all the choices included in the sample, and because the required information is not likely to be available.[3]

(4) Steiner has pointed out that it is not desirable to compress a multi-dimensional objective into a single dimension because it leads to submerging real issues behind a facade of faulty measurements. Bias can run either way: by overvaluing non-market benefits, or by neglecting, as benefits, those differences in public and private goods that are not readily measured. Steiner suggests that you measure what can be measured with confidence and with some accuracy and leave incommensurables to be decided by explicit choice.[10]

(5) The subject of benefit evaluation is not now clearly understood by many persons affected by investment "impacts." These persons have a right to understand and participate in public decision making. An acceptable approach to evaluation would therefore not only provide an opportunity for public participation in decision making, but should also be as uncomplicated as possible.

b. Synthesis. A suitable approach to evaluating noncommensurate outputs combines concepts from Margolis, McKean, and Lord. In this section these concepts are related to the investment formulation process. The manner in which nondollar outputs of water resource projects must be dealt with in formulating water resource investments varies from one phase of formulation to another. In the initial phase, the planner has relatively little concrete knowledge of the "pattern" of public desires, and he is forced to rely largely on his own judgment in determining the relative emphasis which ought to be placed upon various objectives. A second phase begins once the public has seen and reacted to the planner's initial conception of a range of alternatives.

(1) The Conception Phase. In the first phase, which can be called the "conception phase," the planner is groping to discern the emphasis which the public would like to have placed on nondollar-valued outputs relative to dollar-valued outputs. As yet there are no alternatives to which the public can respond, and the first responsibility of the Corps' planner is to provide the public an opportunity to examine a simply-stated and diverse range of alternatives. It is unnecessary at this stage to develop precisely defined quantitative estimates of project effects or to aim toward optimal contributions to any particular objective. Rather, this initial range should be so structured that the public response which it elicits will be helpful in delineating a more narrow range which realistically represents various project-related interests.

A convenient and efficient way to deal explicitly with nonmarket outputs in this initial phase of formulation is provided by the Marglin approach. Certain dollar-valued benefits can be maximized subject to constraints on established levels of benefits which cannot be evaluated in dollars. In order to clearly transmit the relative emphasis among objectives embodied in each of a number of alternatives, proportional dollar and nondollar benefits should be expressed in the form of minimum target level benefit constraints. Since the planner must rely largely upon his own judgment in the design of these initial alternatives, it is important that this judgment is made explicit in his analysis; the Marglin approach is well suited to this task.*

(2) Public Participation Phase. Once the initial range of alternatives has been formulated, the varying mixes and magnitudes of noncommensurate outputs embodied in each of the alternatives can be displayed in Lord's Public Participation Matrix, which incorporates concepts from both McKean and Lord. Persons affected by these alternatives are given the opportunity, in a series of public meetings, to express their interests regarding the suitability of these alternatives.

* The distinction between nonmarket output of national interest and nonmarket output of regional interest should also be made explicit in the initial formulation of alternatives. The determination of what is of national, as opposed to regional or local, significance must come from the Corps' planner at this stage. Differences among alternatives in the proportionality between national and regional nonmarket benefits can be distinguished clearly by identifying the Corps' planner's perception of national and regional interests with explicitly stated benefit constraints.

Inherent in the choice among alternatives, in response to expressed public interests, is the value which has been placed upon nondollar-valued benefits relative to dollar-valued benefits. Where conflicts are not resolvable among the various users of water resource outputs, the Corps' planner will select and recommend the alternative which, in his judgment, best serves his concept of the public interest, whatever that concept might be.

In this system of evaluation the decision maker is not encouraged to think in terms of an explicit relative value to be applied to the available data, but rather to rely on his judgment after viewing the range of alternatives. In the Marglin and the McKean-Lord approach, any choice of a design implies a certain relative evaluation or trade-off balance between valued and unvalued benefits. Choice determines value in both cases.

Freeman has indicated that "it is not obvious to the members of the body politic what relative values are actually implied by the set of choices made in the Marglin and McKean approaches." This criticism would not apply if alternatives which are considered and rejected by the Corps were clearly documented in investment recommendations.[3]

4. The Planning Framework. In the last few paragraphs, several concepts were discussed and related to separate phases of planning. The overall planning process of the Corps of Engineers involves a great deal more than the methodological procedures utilized in identifying, measuring, and evaluating benefits. The total planning function encompasses the comprehension of emerging planning problems

and opportunities and the determination of objectives in the light of these problems and opportunities. For the Public Participation Matrix to lead to investments which respond to expressed desires of project users, the planning framework in which it is used must rest on the principle that: Benefit estimation should not only provide a justification for public investments, but also influence their design, location, and operation. Kneese has pointed out that, in many cases, in public investment planning, the engineering design is fixed, and then the economic evaluation is made.[6] This cannot lead to maximum net benefit. Although Corps' planners may generally accept the above principle in theory, the record of applied planning in the Corps would indicate that not enough emphasis has been placed on following this principle. If this principle is ignored, the use of the Public Participation Matrix as an evaluation tool is reduced to a meaningless exercise. In this light, it is clear that the successful implementation of the Public Participation Matrix is fundamentally dependent upon certain and important modifications in the existing planning framework to allow all elements to be exposed and evaluated.

a. Modification of the Planning Framework. The modifications enumerated below are required for the Public Participation Matrix to become effectively integrated into the planning process.

(1) The evaluation of outputs fostered by the Public Participation Matrix can be expected to be conceptually acceptable if user groups are active and if user groups are indeed given an opportunity to influence the shape of alternative design-solutions. The Public Participation

Matrix cannot be effective if user groups, for one reason or another, are not active. If user groups are not active, there is the possibility that the Corps' planner may package project effects according to user groups, but fail to identify significant factors and judge these factors objectively. Some would argue that projects which are offered up for public consideration and which are unopposed are, by definition, publicly acceptable projects. Others would argue, however, that the government has a responsibility to encourage participation in the planning process by actively soliciting the views of users. The planning function which fully supports the effective utilization of the Public Participation Matrix must stand on this latter view.

(2) Even if user groups actively participate, it is possible that users may be offered, initially, a predetermined range of alternatives which has been tailored to the satisfaction of the Corps of Engineers, or other planning agencies, but not to even the approximate satisfaction of persons affected by the project. This possibility could be considerably narrowed if field planners would attempt to obtain and incorporate attitudes toward resource use into the initial formulation of a project alternative. If Corps' planners' preferences are tempered by consideration of regional attitudes, then user groups will have an opportunity to respond to alternatives which should more closely represent their desires than those formulated otherwise; as a result, reformulation time and reformulation cost may be sharply reduced. While existing evaluation policy in the Corps calls for the recognition of regional

attitudes, there is no mechanism to facilitate and, if necessary, enforce such consideration. Therefore, the planning framework should be modified so that the consideration of regional attitudes is an integral component of the planning function.

(3) The geographical areas on which detailed investment planning is performed by the Corps ranges in size from large regions, such as Appalachia, down to small portions of towns and villages. However, regardless of the size of the area for which planning is undertaken, certain tasks should be accomplished in the performance of sound planning. In the Corps, certain tasks are neglected in planning an investment of small-scope, even though these tasks are equally important for small-scope planning as for large-scope planning. Three of these tasks are fundamental to the evaluation of comparative water resource investment opportunities from a regional perspective: 1) an assessment of the physical attractiveness of the regional landscape for a variety of potential land uses; 2) the assessment of major planned public investments within the relevant regional setting; and 3) the definition of opportunities for cooperative efforts among planning agents aimed toward the solution of regional problems and the realization of regional potentials.

b. Implementation of the Conceptual Framework. A problem exists in implementation of concepts and methods for evaluation once a conceptual framework has been set. Two important initial steps can be taken to provide a foundation for organizing and implementing the recommended evaluation approach:

(1) Provide more and better information for all levels of decision making; and

(2) provide for the systematic submission and review of information displays throughout the planning process to insure that a broadened and improved information base is fully and objectively considered at all levels of planning within the Corps.

An information system which accomplishes these two steps can provide a bridge between the Public Participation Matrix and the modified planning framework.

The key decision maker in the conception phase* of project formulation is the Corps' planner; in the public participation phase of formulation, the project user; in the program-budgeting phase, the Department head; and in Congressional decision-making, the public representative. The design of an information system should be calculated to provide appropriate information to each of these levels.

In the first phase of formulation, the conception of alternatives, the Corps' planner requires information which assists him toward:

- 1) seeking out opportunities to realize potentials as well as opportunities to ameliorate undesirable conditions;
- 2) assessing the interrelationship of the significant regional factors which affect the regional setting;
- and 3) coordinating with the major agents attempting to deal with factors which significantly affect the regional setting.

* Conception Phase: described on page 17.

In the public participation phase, the project user requires information describing the consequences of alternative designs in terms of how these consequences benefit or harm his personal interests.

In program budgeting and congressional decision-making, the decision-maker is primarily concerned with the extent to which investments, singularly and collectively, contribute toward achieving various regional and national objectives.

Part IV develops the conceptual outline of an information system which supplies and controls the flow of most of the significant information inputs and outputs of the overall planning function.

PART IV

AN INFORMATION SYSTEM TO SUPPORT THE EVALUATION OF NONMARKETED OUTPUTS

1. Scope. The scope of the information system outlined below is narrow in that it is concerned largely with environmental quality, which is only one of many possible objectives of water resource investment. The scope is relatively broad, though, in the sense that the methods and procedures engage the entire planning process. To the extent that this system has value as an initial step toward evaluating environmental objectives, it also has value as a framework for developing an information base for dealing with other objectives. A particularly strong point favoring the system is that it can be implemented immediately, and that the system offers necessary internal flexibility in the manner in which objectives and impacts are handled at the field level as well as the operational flexibility required to permit uneven development of the system by field personnel.
2. Objective. The broad objective of the information system is to develop and display information which supports the evaluation of selected environmental outputs within a planning mission which seeks:
 - a. To achieve the development of environmental potentials as well as to avoid negative environmental effects.
 - b. To assess the interrelationship of factors which significantly affect the environment and which seeks coordination with the major agents attempting to deal with these factors.

c. To provide the public an opportunity in the early stages of planning to consider detailed information about the environmental consequences of investments.

d. To assure that environmental planning within the Corps represents the public interest by soliciting not only public responses to alternative solutions, but also public attitudes regarding broad environmental opportunities and problems.

3. Goals. To accomplish the above objective, the information system outlined below has been designed to provide:

a. A continuous and visible information conduit which links data collection and interpretation, output measurement and evaluation, and regional environmental needs.

b. A classification and terminology through which selected environmental impacts can be compared in common terms in order to facilitate meaningful intra-regional comparisons of environmental problems and potentials; and interproject comparisons, and regional summations of environmental consequences of projects and plans.*

c. An internal information review process which forces the objective interpretation of environmental data/information throughout the planning process through the display and review of a series of distinctly expressed information sets at various stages of the planning process.

* For example, see the general and region-specific classes of impacts in the matrix on page 32.

4. Constraints. The extent to which the objectives and goals outlined above can be successfully carried out is dependent upon many factors. Of these factors, perhaps the most crucial is the disposition of the field planner. It is relatively easy to adapt and synthesize theoretical concepts and to develop procedural schemes; the acid test of workable planning procedures, however, is acceptance and application of new concepts and procedures by the field planner. It is from this viewpoint that a special effort has been made to acknowledge the following factors: a) the planners' attitudes and b) professional skills. These factors are considered constraints inasmuch as the response required to meet environmental planning problems cannot reasonably be viewed from a long-range standpoint.

a. Planners' Attitudes.

(1) Sample Survey of Planners' Attitudes. What problems and needs should be addressed in order to improve environmental planning? This question was asked of a sample of planners from the Detroit, Chicago, and Pittsburgh Districts, and the North Central Division of the Corps of Engineers. Generalizing from this small sample, the following inferences can be drawn regarding the successful implementation of the information system recommended here:

(a) Implementation of the information system should not impose rigid organizational and staffing requirements on the Districts.

(b) The information system should not be restrictive in terms of:

(1) the role of other agencies and the public in the formulation of Corps' projects; or (2) the scope of environmental considerations which

should be dealt with in the formulation of alternatives (i.e., the extent to which indirect effects of environmental change, such as social and industrial development effects, should be assessed in project formulation).

(c) Changes in the public participation/communication aspects of planning are warranted and are, perhaps, the most needed of a variety of suggested procedural changes.

(d) The Corps should take a positive role in environmental planning; positive environmental effects of projects should be taken into account.

(e) Acknowledgement of the policies and guidance of other government agencies planning for the use and development of water and related resources is an important component toward improved environmental planning in the Corps.

b. Professional Skills. Success in carrying out the planning function will be influenced significantly by the distribution, size, and expertise of the existing Corps' planning staff relative to the distribution and complexity of the diverse planning problems which prevail throughout the country. An important question is whether District-level personnel should carry out the entire analysis to determine the location and kinds of projects which best contribute to multi-objectives. In most cases, survey-scope planning has been accomplished by District-level personnel without the benefit of Framework Studies. Accomplishment of the objectives set forth above may require a manpower capability which we do not now have at the District level.

5. Organization. The broad and imaginative thinking and the interdisciplinary knowledge required to analyze regional problems cannot

be developed throughout the field in the short-run by merely issuing guidelines and holding periodic training sessions. While the present lack of expertise should be considered temporary, the need for improved environmental planning is immediate, and can be met most effectively through reorganization of existing manpower and through limited recruitment. Whatever level of professional staffing may be needed among Districts and Divisions, these needs should be satisfied on an individual basis.

Because of the size and complexity of the overall task of assessing regional problems and potentials and making interregional comparisons among investment opportunities, the District offices of the Corps would necessarily carry the lion's share of the planning load. In order to obtain the maximum return from the professional skills throughout the Corps, it would be appropriate to assess the varied professional expertise existing within the organization. Based on this assessment, interdisciplinary teams to perform certain critical planning tasks at the Division level would be established.

Without the benefit of a detailed study, it would appear that Division offices might be relied on to accomplish the following functions:

- (1) Assess the regional setting;
- (2) Determine regional objectives; and
- (3) Set the regional context within which survey-scope planning should be carried out.

District offices might be relied upon to:

(1) Collect, assimilate, and supply basic data and information to Division offices where it can be compiled and analyzed within a regional context.

(2) Formulate Projects and Plans within the regional framework established by the Division Office: a) analyze the adequacy of the water resource to meet regional objectives; b) analyze the costs and benefits associated with alternative projects designed in response to multiobjectives; and c) design feasible projects to meet the requirements of regional multiobjectives.

6. The Information System. The Information System includes three major components: a) Judgment-free Data Bank; b) Environmental Profile; and c) Information Displays. These components are briefly described below. In the next section, the Information System is explained and related to the planning process.

a. Judgment-Free Data Bank. The Data Bank provides spatially defined, judgment-free basic data necessary for improving environmental planning through the methods and procedures outlined below. The Data Bank will be drawn on during various stages of planning, but primarily during the early stages. Appendix A defines and explains the role and format of the Data Bank.

b. Regional Environmental Profile. The Environmental Profile includes three principal parts: 1) a summary statement of the nature and magnitude of major federal and state programs affecting land use; 2) a short-run forecast of regional environmental change; and 3) a statement of dominant regional environmental problems and potentials. Parts 2 and 3 will draw heavily upon the data provided by the Data Bank.

c. Information Displays. The Environmental Information System requires the submission and review of two major information displays during plan formulation: 1) Environmental Impact Display, and 2) Public Participation Display.

(1) Impact Display. The Impact Display is in the form of a matrix and an accompanying narrative. This display will be developed during the initial conceptualization of alternative design-solutions, following the first public meeting. The matrix will relate classes of project effects to a series of alternative designs. Project effects include classes which are relevant to only region-specific environmental problems and potentials, as well as several standard classes which are of general concern in all regions. The cells of the matrix will include either a positive or negative sign or a zero. Whether project-induced environmental changes are considered positive or negative will, at this stage, depend largely upon the interpretations and preferences of the Corps' planner. Each cell in the matrix will be footnoted, and the impacts of the physical changes described in a brief narrative. As shown below, this matrix provides an easily understood and visible tool for summarizing project effects for a range of alternatives.

Two types of impacts are shown in the Environmental Impact Matrix: 1) environmental impacts which are of general concern in all regions (e.g., ecological, visual); and 2) environmental impacts which are of particular concern only within the region in which the project is found. An example is impacts on open space in "urban" regions. A common

ENVIRONMENTAL IMPACT MATRIX

Environ. Effects Alternatives	General			Region - Specific		
	Ecologic	Visual	Human- Cultural	Variety	Open Space	Acid Mine Drainage
Design A						
Design B						
Design C						
Design D						

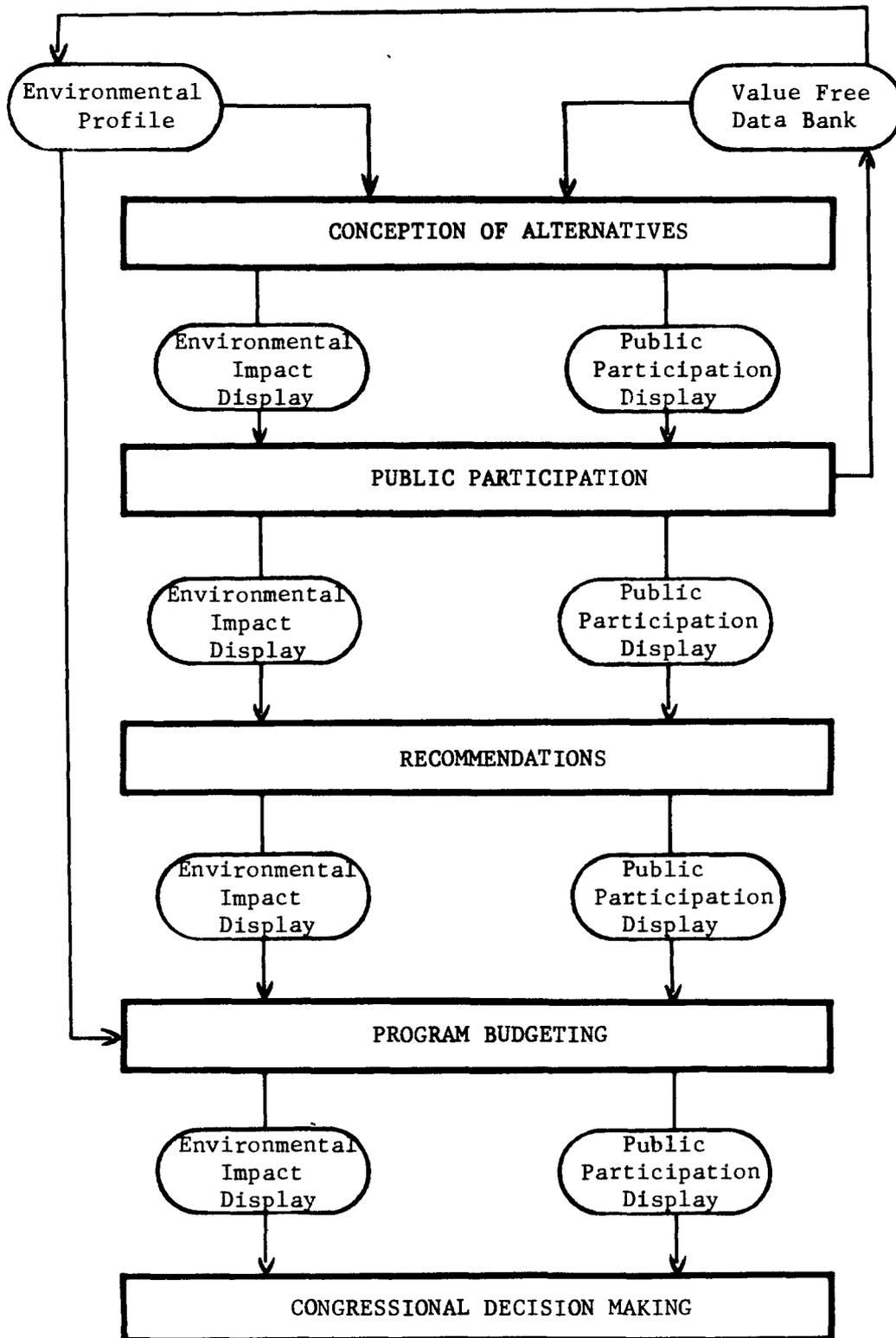
classification for region-specific environmental problems and potentials in the Environmental Profile and region-specific project impacts in the Environmental Impact Matrix provide a basis for making intra-regional comparisons of project consequences in terms of a variety of regional environmental objectives. The availability of an Environmental Impact Matrix for each project will also make it possible to develop regional summations of selected classes of project effects for various combinations of projects within a given region.

(2) Public-Participation Display. The Public-Participation Display, also in the form of a matrix and an accompanying narrative, relates project impacts to region-specific user groups. One Public-Participation Display will be developed for each alternative offered for public consideration. This display will serve as a means to obtain public response to alternative project designs, and as a means of reflecting modifications among alternatives in response to expressed public preferences. The user groups which are affected by project effects will include local conservation-preservation-natural beauty interests, local commerce - tax base - oriented interests, state and local economic development interests, outdoor recreation interests, and other relevant region-specific interests. As shown below, in the Public-Participation Matrix, the physical impacts of each alternative are listed along the left side of the matrix, and the user groups affected by these effects are listed across the top of the matrix. The cells of the matrix include either a positive sign, a negative sign, or a zero. Whether project-induced environmental changes are considered positive or negative will depend upon the preferences of user groups. Each cell will be footnoted to provide a narrative description of the impacts of the physical changes depicted in the matrix. The narrative will trace the impacts of project-induced physical changes over time to discern the full implication of changes expected to result from induced use of the impact area. Environmental impacts (e.g., ecological, visual, open space effects) are described in the narrative along with developmental, social, and other relevant classes of impacts.

PUBLIC PARTICIPATION MATRIX

Interests Affected Impacts	Recrea- tionists	Conserva- tionists	Economic . Interests	Etc.
Environmental a. Ecological b. Visual c. Human-Cul- tural d. Etc. Developmental a. b. Social a. b.				

7. Operation of the Information System. The diagram below shows each component of the Information System as an input to the planning process. The discussion which follows explains how each component is expected to improve planning.



a. Regional Environmental Profile.

(1) The major function of the Environmental Profile is to provide a regional context within which projects and plans can be formulated. In survey-scope studies, the river basin or specific project area is often considered as an isolated geographical entity, taken to represent the relevant environmental setting for planning purposes. This narrow perspective is largely due to a lack of readily available "hard" regional information and the lack of resources available in survey-scope studies to make a comprehensive assessment of the significant regional factors which should be considered. For water resources investments to effectively realize environmental potentials and to avoid negative environmental effects, it is necessary to build into survey-scope studies the broad perspective and the federal/state agency cooperation which we have in Type I studies; the Environmental Profile is designed to help accomplish this.

(2) In addition to providing a planning framework to guide field-level formulation of basin plans and project studies, a second major function of the Profile is to provide a partial basis for the rationale for the five-year PPB regional investment program. The Profile would be submitted along with the "Narrative" of major developmental problems which each Division now submits to OCE in connection with the planning-programming-budgeting process.

(3) The classification of regional problems and potentials and related objectives utilized in the Regional Profile will also be applied to categorizing project environmental effects in the Environmental Impact Display.

b. Preparation of Regional Profile. The Regional Environmental Profile might be developed almost entirely by the Division-level staff, with assistance from other governmental agencies and from interest groups and individuals as applicable. Fundamentally, the Profile would represent the Division's interpretation and analysis of aggregated regional environmental data and the desires and plans of state and federal agencies. The steps involved in developing the regional profile follow:

(1) Identify state, federal, and significant urban, metropolitan and other objectives and priorities regarding the environmental resources; e.g., wild rivers, coastal protection, open space acquisition, water quality, outdoor recreation, etc., as expressed in plans and programs.

(2) Survey ongoing and planned federal, state, and other significant programs affecting the use of land and water resources within the region; e.g., highways, water development, model cities, new towns, urban renewal, etc.

(3) Determine projected levels of regional population and economic activity.

(4) Assess for each OBERS sub-region* the general consequences of plans and programs as defined in (2) above; and population and economic activity as defined in (3) on objectives and priorities as defined in (1). Define conflicts.

* Economic and Water Resource Sub-regions for which population, employment and income projections have been developed jointly by the Office of Business Economics and the Economic Research Service.

(5) Identify opportunities for federal and/or state-federal action (with or without Corps' participation) to a) resolve conflicts defined in part 4 above and b) to expedite and facilitate environmental objectives and priorities as defined in part 1 above.

(6) Identify Corps' environmental planning priorities in region.

c. Data Bank. The Data Bank provides an accurate, comprehensive, and judgment-free set of data stored on a grid basis in a format which can be aggregated and disaggregated rapidly and easily to satisfy the needs of both large-scale and small-scale planning. A detailed explanation of the construction and use of the Data Bank is provided in Appendix A.

d. Project Formulation. The Data Bank and the Environmental Profile are available to the planner at the beginning of project formulation. As discussed above, the Data Bank and Profile will provide a broad projective setting which will assist the planner in the initial conceptualization of project solutions.

The planner will develop a range of alternatives, displaying the environmental effects of each alternative according to the Impact Display format described above. As explained in Appendix A, the positive and negative effects of project-induced changes in land use can be determined at this stage by relating land use changes to: 1) resource characteristics stored in the Data Bank, and 2) related standards which have been chosen to constrain the design-solution at varying levels. Division-level review of the Impact Display during project formulation will insure that the District planner has

fully acknowledged the data provided in the Data Bank and the Environmental Profile, and will reflect the fullness of the range of alternatives and the range of objectives which he has considered in his search for a solution. Division review of the Impact Display early in the planning process should contribute significantly to streamlining the planning process through early redirection of the planning effort as indicated.

The use of a common classification of environmental impacts among projects (i.e., ecological, visual, human-cultural) for describing and separating project environmental effects in the Impact Display will make it possible, later in the planning process, to consider the cumulative effects of various combinations of projects on separate classes of environmental change. Classes of environmental effects will be matched with respective classes in the Environmental Profile, which would naturally vary from region to region depending upon the nature of the environmental problems and potentials of a given region. Thus, the Impact Display can provide explicit environmental information for decision-making at the program-budgeting stage of planning as well as at the project formulation stage.

The initial range of alternatives will be considered and modified as necessary during a series of informal formulation meetings in which user groups significantly affected by the alternatives are given an opportunity to express project-related interests. Environmental impacts of alternatives presented during public-participation meetings, together with impacts on other relevant objectives, will be displayed in accordance with the Public Participation Information Display described above.

APPENDIX A
JUDGMENT-FREE DATA BANK

1. INTRODUCTION

The Data Bank outlined here is designed to store information in a form which can be conveniently and efficiently utilized in the operation of the evaluation framework outlined in Parts III and IV. This Appendix does not prescribe the content of the Data Bank, but defines and justifies its role and format. The major purpose of the Data Bank is to provide a central supply of data which can be drawn on continuously over time in the development of both large scale and small scale plans aimed toward a variety of objectives.

2. ROLE AND FORMAT OF THE DATA BANK

Many of the problems which Corps' planners face today result from complex interactions among a wide variety of physical, biological, and social factors. To understand these problems and to investigate alternative solutions, it is necessary to study as much of the whole problem situation as is practicable. Data which interact to create either problems or opportunities should be stored in the Data Bank in a form which permits convenient interaction and superimposition of data on a selective basis. The extent and nature of the concern which a planner has for the natural environment, for example, is often a function of population change, industrial development, the technological

character of production and other equally significant factors. The interrelatedness of a system of variables such as these is further complicated by shifts in the scope and/or scale of alternative designs during plan formulation. With such shifts the character and amount of required data often changes, as does the geographical area under consideration. The iterative nature of the formulation process makes it highly desirable to collect information in a form which can be easily and efficiently updated and aggregated and disaggregated over time without harm to the quality and usefulness of unmodified portions of the Data Bank.

In the determination of objectives and the evaluation of impacts, data are used in three fundamental ways: 1) to describe, 2) to measure, and 3) to evaluate. Two important premises relating to these three uses underlie the development of the Data Bank: a) the Data Bank should be judgment-free; and b) the Data Bank should be described in a format which facilitates measurement and the application of standards.

a. Judgment-Free Data.

In those cases where data are or can be reused more-or-less continuously over relatively long periods of time in a variety of planning situations, it is often efficient to hold such data in a judgment-free form, separate from other important data which are necessarily judgment-laden. One of the important purposes of the Data Bank is to eliminate redundant data collection and data processing by providing a central supply of information which serves a spectrum of objectives and many users. The usefulness of various types of data is severely impaired if

values taken at one point in time and relevant only within a fixed context are congealed in the data. With each new planning context a particular set of data may take on different relative values; the imputation of value in such cases restricts the application of the data to a small portion of its potential application.

The content of the Data Bank must vary from region to region, but the format in which the data is stored should be compatible among regions. The specific categories that should be included in the Data Bank are best determined by Corps' planners developing the Data Bank at the field level. Following is a partial list of judgment-free data categories which might be included in the Data Bank:

- (1) climate
- (2) geology
- (3) topography
- (4) land forms
- (5) soils
- (6) water
- (7) vegetation
- (8) wildlife
- (9) land use
- (10) accessibility
- (11) population
- (12) employment
- (13) income

b. Standards.

To carry out the role of the Data Bank outlined above, the data should be stored, analyzed and displayed according to grid cells. Each of the data variables which describes the grid cells should be scaled to a numerical code for ease of handling by a digital computer. After data categories are selected and cell boundaries are adequately described, each of the data variables can be mapped, if practicable, using computer techniques.

Given location-specific data, the planner can identify environmental quality standards with explicitly stated constraints (the Marglin approach, page 12.) These standards can be related to resource-related characteristics within two fundamental planning strategies: 1) the planner may determine for a given region or project area, the vulnerability of the landscape to damage, and from this determination he may select a pattern of proposed land utilization which will minimize damage to the environment; or 2) the planner may determine the relative attractiveness within a region or project area for a variety of proposed land uses, and from this determination, he may then select a pattern of land utilization which takes advantage of this attractiveness.

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<p>Many environmental and social aspects of water resource projects cannot be adequately evaluated in dollar terms. This report: establishes a foundation for systematically and objectively identifying and evaluating environmental and social impacts and for determining environmental and social objectives; develops a permanent structure for receiving, holding, and releasing information which should be considered in assessing environmental problems and potentials; and, develops a regional context within which investment consequences can be evaluated, so that anticipated developments can be viewed against the suitability and capability of a regional environment to accommodate change induced by a project.</p>			

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