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FEDERAL EVALUATION OF RESOURCE INVESTMENTS: A CASE STUDY

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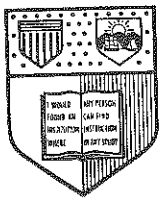

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PREFACE AND ACKNOWLEDGEMENTS

In their report of June 1969 entitled "Procedures for Evaluation of Water and Related Land Resource Projects," a Special Task Force of the Water Resources Council (WRC) proposed changes in the criteria, methods and procedures used to evaluate proposed public resource investments. As part of its recommendations, the Task Force suggested that, prior to any revision of the WRC's Planning Policies (published as Senate Document No. 97, 87th Congress, 2nd Session), "the proposed procedures be tested on representative projects and that Federal agencies prepare critical reviews of the procedures."

After regional and national hearings had been held on their report, the Special Task Force proceeded to select projects to be used in carrying out their recommendation on testing. An interagency test team and independent test teams from the various resource construction agencies were put together to carry out the actual tests. In addition, early in the summer of 1969, the WRC was asked by several academic institutions to cooperate with them in making independent tests of the proposed procedures on the same or similar projects as those to be used by the federal test teams. This research report is a direct result of that request and the cooperative agreement negotiated between the WRC and Cornell University to fund and support that type of effort within the Department of Agricultural Economics. By entering into such an agreement both parties hoped to further improve and perfect the standards, criteria and procedures to be used for water resource development and management.

Special thanks is given to Dr. Harry Steele of the WRC for his interest and cooperation in making this test possible. The cooperation of the personnel of the Cincinnati Division and Pittsburg District offices of the U. S. Army Corps of Engineers is gratefully acknowledged. The cooperation of Wayne Ehlers, Jim Mershimer and Jim Prudy in providing briefings, information and time for touring the case study site and the Corps Pittsburg office with members of our test team is deeply appreciated. Special thanks are due to Mrs. Lanie Wilmarth for her role in manuscript preparation and typing.

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SUMMARY

In applying the Water Resources Council's proposed evaluation procedures for water and related land resource projects to the U. S. Army Corps of Engineers' proposal for a Stonewall Jackson Reservoir on the West Fork River in West Virginia, the Cornell University test team raised a wide range of conceptual and empirical issues. A full reading of the report is necessary to adequately evaluate our handling of these issues. However, we will attempt to summarize here the general nature of these concerns with respect to benefit and cost measurement and formulation of alternatives for multiple-objective planning.

Empirical implementation of the four components of the multi-dimensional social welfare function required major additions to existing methodology. For example, the test team needed to develop completely new methods to handle the measurement of income distribution consequences of project construction as required by the proposed regional and well being accounts. Likewise, the environmental quality account, as the only non-economic evaluation of a project, required special handling and suffered from perhaps the least consensus about its conceptual foundation, method of implementation and measurement. Nor did the traditional national economic efficiency account emerge unchanged. Previous methods of measuring water quality and recreation benefits were found inadequate and suggestions were made for improvements which would bring measurement methodology in line with theoretical principles. For the three economic accounts, special consideration was given to the issues of unemployed resources, productivity change and expansion impacts of project construction and operation.

In almost every case, existing sources of data and needed subsidiary studies were found to be inadequate for accurate application of the appropriate methodology. In several cases, new data sources were discovered and used but the need for additional data collection and research in most areas was apparent.

In light of both the methodological and data issues, the test team found that broadening the framework of project analysis beyond national economic efficiency, to include the additional criteria of regional development, social well-being and environmental enhancement, in no way reduced the need for careful and conceptually sound evaluation of the traditional efficiency impacts. In fact, analysis showed that increased emphasis should be placed on these efforts because:

a) Primary benefits will continue to make up the bulk of the positive impacts in any national efficiency analysis;
b) The two new economic accounts (regional and well-being) use estimated efficiency impacts as the basis for determining the initial impacts for these accounts;
c) Deviations from the most efficient solution can be used to measure the opportunity cost of achieving other aspects of social welfare.

It should be noted, however, that placing emphasis on measurement of effi-

ciency impacts (positive or negative), for the reasons given, does not diminish the need to develop methodology for the new accounts which will enable the analyst to properly evaluate the quantitative data in relation to the appropriate objective.

With respect to the formation of alternatives for evaluation, the test team found that the Task Force report had not presented a means whereby alternatives can be limited, choices made, tradeoffs between each component highlighted, and proper options retained. Moreover, following the Task Force suggestion that one alternative be designed to emphasize each objective can lead to a situation where a possible second best solution is ignored. The test team proposed that the consideration of alternatives must be limited to alternative ways of providing for water "needs" when needs are defined as problems related to water functions like flood control, recreation, wild rivers etc. Thus, water needs do not refer to national objectives like economic efficiency or regional growth. Project investments are not made because of these objectives, but rather are measured by them. Making higher level tradeoffs between governmental functions (water related investments and education, for example) to meet national objectives cannot be accomplished through a simple accounting framework. Flowing from this set of propositions is the notion that governmental decisionmaking must depend on the group process to both define alternatives to meet needs and to make the ultimate decisions between these alternatives, and between functional areas of governmental involvement. No agency or group of agencies should internalize the process because appropriate alternatives can be ignored and proper weighting of objectives is not subject to a priori quantification.

Locking a uniform measure of social benefit from different activities, public allocation of resources is in response to a social welfare function that implicitly weights competing resource users. Group politics essentially involves efforts of these users to gain a higher priority in the overall welfare function. There is no central allocating authority. Allocation results from bargaining among groups, guided by various institutional arrangements. Therefore, the test team concluded, from its experience, that the new procedures are a very important innovation - an institutional adjustment to demands by groups for a better definition of the overall welfare function. They do not, however, facilitate objective or definitive answers because none are available at this level of decisionmaking. The procedures do provide new access points to the decision process and permit a useful categorization of information for groups to use in their efforts to influence that process. Therefore, the overall purpose of the federal use of these procedures should be to present as much information as possible, within the framework established, so as to facilitate the consideration of alternatives and the overall bargaining (or advocate) process. Although the methodology and data for accomplishing this objective, by using multiple-objectives, is currently less than ideal, the process is feasible and can best be improved by its immediate but cautious implementation.

FEDERAL EVALUATION OF RESOURCE INVESTMENTS: A CASE STUDY

INTRODUCTION AND PURPOSE

This report presents the results of a research effort whose principal objective was to empirically test the procedures recommended for evaluation of public resource investments by a Special Task Force of the Water Resources Council.[1] The main recommendations of that task force included a broadening of the traditional framework of project analysis beyond economic efficiency to include the additional criteria of regional development, environmental enhancement, and well-being of people. Flowing from this set of suggestions were recommendations on the definition of the "benefits" and "costs" to be used with the respective accounts of the broaden welfare function, suggestions on methodology to be used to measure these impacts, implications for the division of project costs among the accounts and recommendations pertaining to the improved evaluation of alternative courses of action to meet national goals.

A number of economists and political scientists have suggested and agreed with the general rationale for evaluation of multiple objectives and the policy direction taken by the Task Force report.[2] However, as the Task Force recognized, the methodology outlined for implementation was often not fully developed or was, at times, inconsistent with theoretical principles. Thus, they sought a "full analysis of the problems and processes involved in measuring effects and formulating projects."[3]

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[1] Water Resources Council, Procedures for Evaluation of Water and Related Land Resource Projects, Report by a Special Task Force (Washington), June 1969.

[2] Robert J. Kalter et al., Criteria for Evaluation of Resource Investments, Cornell Water Resources and Marine Sciences Center (Ithaca, N. Y.), Aug. 1969.

Jim J. Tozzi, Establishing Priorities for Public Investment, Systems Analysis Group (Civil Functions), Office Secretary of the Army (Washington), June 1969.

Stephen Marglin, Public Investment Criteria (Cambridge: MIT Press), 1968.

Burton A. Weisbrod, "Income Redistribution Effects and Benefit-Cost Analysis," in S. B. Chase, Jr. (ed.), Problems in Public Expenditure Analysis, (Washington, D. C.: The Brookings Institution), 1968.

Arthur Maass, "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions," Quarterly Journal of Economics, Vol. LXXX (May 1966).

For an opposing view see: Jack L. Knetsch et al., Federal Natural Resources Development: Basic Issues in Benefit and Cost Measurement, Natural Resources Policy Center, The George Washington University (Washington), May 1969.

[3] Water Resources Council, "Instructions for Testing," Special Task Force on Evaluation Procedures (Washington), Sept. 1969, Mimeo, p. 1.

The result was a recommendation that the procedures suggested be subject to testing by an interagency test team, test teams of the construction agencies themselves, and interested nonfederal groups such as state planning agencies and academic institutions.

As formulated by the Special Task Force, the testing process would involve the application, by separate and independent test teams, of the suggested procedures to the same project. As they pointed out:

> The test should provide a basis for assessing the recommended procedures under conditions where the major determining factor in their application will be the understanding and interpretation of the recommended procedures by separate teams when applied to the same project. . . . To develop procedures more fully, it will be necessary for the Task Force to have reports on how the different teams working on the same problem and using the recommended procedures apply their judgement and make critical decisions affecting formulation and evaluation. In this way, the Task Force can identify the key points in the formulation and evaluation process where more specific guidelines are needed.[4]

The Task Force also proposed that the individual tests cover two distinct areas of emphasis. The first relates to the:

> . . . identification and measurement of program or project effects (benefits and costs) contributing to or associated with the major national objectives. This aspect of the test would be directed to assessing the entire range of benefits and costs of the project as presently formulated.[5]

The second aspect concerns the formulation of:

> . . . alternative plans with varying mixes of the national objectives as set forth in the Task Force report. The purpose . . . is to determine the adequacy and the deficiencies of the general procedures available for multiple-objective project formulation. This step is to test formulation procedures rather than to actually develop in a technical sense the engineering and economic detail for the projects being tested. If feasible, at least one alternative plan should be formulated emphasizing each relevant national objective.[6]

The approach of this research effort is patterned along those lines. Thus, what follows is a separate section on each of the four criteria suggested for project evaluation. When necessary interpretations of the language used by the Task Force were made in order to more clearly define

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[4] Water Resources Council, "Plan for Testing Evaluation Procedures," (Washington), mimeo.

[5] Ibid.

[6] Ibid.

the bounds of an account so that empirical work could proceed. These interpretations are clearly noted. Following the four sections on criteria, a separate section is devoted to alternatives in plan formulation and to a system of accounts necessary to display evaluation results. As an introduction to the analytical sections of the report, a discussion of the relationship of institutions to the proposed evaluation procedures is presented.

Each of the authors had primary responsibility for one section of the report but ideas, review, comment, and editorial assistance were mutually interchanged. Because of the limitations in time, money, data and personnel, specific sections were treated in more depth and detail than others. However, efforts were made to consider all appropriate areas to the extent possible. In general, each major section includes subsections on the conceptual foundation for evaluation of the particular objective, methodology necessary and appropriate for such evaluation, data needs and possible data sources for empirical implementation, consideration of actual data sources and a summary of specific data problems, empirical testing of the methods proposed with realistic hypothetical data if necessary, and appropriate display of research findings.

Although tests were to be conducted on at least ten separate projects, the project chosen by the Cornell team was the proposed project of the U. S. Army Corps of Engineers on the West Fork River, West Virginia known as the Stonewall Jackson Reservoir.[7] The West Fork basin is part of the headwater area for the Monogahela River and flows through an area typical of northern West Virginia.[8] The project involves a concrete dam and reservoir at Brownsville, West Virginia which would be multipurpose in nature.

INSTITUTIONS AND WATER RESOURCE MANAGEMENT

There are a number of working definitions of the term "institution". Sociologist Talcott Parsons has elegantly defined institutions as "techniques

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[7] The project proposal is described more fully in: Senate Document No. 109, 89th Congress, 2nd Session. It should be noted that since project authorization, the project proposal has been somewhat redesigned in the preconstruction planning phase to emphasize the outdoor recreation component to a greater extent. The test team, however, viewed this as a different alternative and elected to test the original proposal. The principal differences in the two proposals, from the viewpoint of this test, were the differing methods of recreation demand estimation and the benefit and cost magnitudes involved.

[8] Pertinent descriptions of the natural, economic and human resources in the project study area will be given, as appropriate to the analysis, in the various sections of this report. Further descriptions of the basin can be found in Sen. Doc. No. 109.

for integrating value patterns of the common culture of a social system through their interaction in the definition of role expectation and organization of motivation."[9] While admirably inclusive, this isn't very helpful. For questions of resource management, institutions may be thought of as structural guides, or parameters to action--an identifiable unit or series of laws and regulations, or an authority that directs relationships among competing resource users. Institutions help to balance the power among competing interest groups. The essential point of departure for institutional economics is that actors in the economy--individuals or groups--have differing levels of power to command a price or a product. Institutions don't necessarily define action, but they provide an acceptable zone of action.

We can assume that the role of government, as a set of institutions, is to allocate resources among activities according to the "public interest"--or some conceptual social welfare function. Federal and state agencies, local districts, water laws, etc. are vested with funds and authority to act in this manner. Conceptually, the welfare function of society is some weighted composite of individual or group welfare functions, though not necessarily a summation of those functions. This conceptual model is behavioral, not structural or normative at this stage.

Thus, it is posited that the overall social welfare function is a weighted composite of group functions and weights are operationally established by the relative political power of each group in the composite. This concept follows from the notion that government itself is nothing more than a collection of groups. Government is the "referee" among competing groups. It is, thus, meaningless to talk about removing the influence of special interest groups in resource management decisions and relying on some mythical "objective" analysis. Public decisions affecting water use or anything else are essentially a compromise among competing groups, some of which may introduce objective analyses to support their divergent points of view.

Schubert,[10] Bentley,[11] and Truman[12] have all discussed the nature of group interaction in some detail. Groups are taken to be the basic political units of society. There is intra-group conflict, certainly, but the internal process by which a group reaches a position is not of concern here.[13]

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[9] Talcott Parsons and Neil Smelser, Economy and Society (New York: The Free Press, 1965), p. 102.

[10] Glendon Schubert, The Public Interest (Glencoe, Illinois: The Free Press, 1960).

[11] Arthur Bentley, The Process of Government (Chicago: The University of Chicago Press, 1908).

[12] David Truman, The Government Process (New York: Alfred Knopf, 1962).

[13] See: James Buchanan and Gordon Tullock, The Calculus of Consent (Ann Arbor, Mich.: Univ. of Michigan Press, 1962).

Groups define the overall social welfare function by expressing demands or a particular notion of how resources should be used. There are numerous access points for political input, and screening mechanisms to control the nature and number of demands made on the political system. Access points also serve as feedback links to the political system to indicate support for or rejection of system output.[14] A key role of institutions, then, is facilitating definition of the social welfare function (public interest) and expressions of support or rejection of the resource distribution pattern that occurs.

To assure any kind of order out of this chaos of group competition, we have to assume some components of social welfare are shared among all groups, to differing degrees. Arrow,[15] Rothenberg,[16] and others express this need for some central value thrust of society. Efficiency, progress, equality, freedom etc. have been identified as major value-orientations of American society. We say, then, that each group welfare function has some component of resource efficiency, and equality of opportunity or income. But "efficiency" is likely to relate to a particular activity--for example, how may irrigation water be provided most efficiently. Institutions are established to allocate resources among competing groups--settle disputes, regulate use, supervise the bargaining process--in ways that are consistent with the basic value orientations of society.

Economic welfare theory establishes the rules or the focus for this broader conceptual framework. The marginality of a welfare optimum is directly analogous to optimality conditions for the perfect competition model in economic theory or for the optimum resource use conditions of production economics. Basically, the goal is to maximize the discounted present net social benefit of water resources. If total benefit and cost curves could be plotted, the optimal point would occur where slopes are equal. If social welfare output of a water-using activity were calculable, then setting the first derivative of the total welfare output equal to the ratio of per unit water "price" to social value of a water unit in that use would give the optimum level of water use for that activity. If these production functions were available for all competing water users (e.g. recreation, navigation, pollution control), then the welfare economist could optimize water use by equating the marginal social values of a unit of water use in these various components of the social welfare function. For water resources, this would be a Pareto optimal situation--shifting resources would reduce the social benefit of some activities. Production economists employ these analytical techniques in recommending

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[14] For a more complete discussion of the systems mechanisms through which groups may act, see: David Easton, A Systems Analysis of Political Life (New York: John Wiley and Sons, 1965).

[15] Kenneth Arrow, Social Choice and Individual Values (New York: John Wiley and Sons, 1951).

[16] Jerome Rothenberg, The Measurement of Social Welfare (Englewood Cliffs, N. J.: Prentice-Hall, 1966).

allocation of land among farm enterprises, or level of fertilizer use for a particular product. Early welfare theory held closely to this notion of measureable utility from "welfare" producing activities. The problem in public allocation is, of course, the difficulty in deriving a satisfactory unit of social benefit for water-based recreation or similar resource uses.

Even if social production functions could be devised for water users, water is not perfectly mobile and not of uniform quality or availability. Social outputs from the alternative activities are interrelated--there are externalities. And public projects for resource developments of various kinds come in rather discrete, lumpy units. Benefit-cost analysis is designed to evaluate discrete policy alternatives that are relatively similar, in terms of their net contribution to social benefit, while maintaining that utility indeed is measureable. The notion of economic efficiency in benefit-cost analysis pertains primarily to maximizing return from project dollars rather than optimum allocation of natural resources among competing activities. Some sort of non-marginal political economics has been suggested for evaluating public projects of differing kinds where analytical problems are distinct from those in production economics.[17] Systems analysts are starting to acknowledge the impossibility of stating a reasonable objective function to maximize and are conceptualizing a broader notion of "system".

Lacking a uniform measure of social benefit from different activities, public allocation of resources is in response to a social welfare function that implicitly weights competing resource users. Group politics essentially involves efforts of these users to gain a high priority in the overall function. There is no central allocating authority. Allocation results from bargaining among groups, guided by various institutional arrangements. The overall social welfare function may be depicted as a multisided Edgeworth Box with a maze of intersecting indifference curves. Any indifference curve tangency along the contract curve would be an optimum for that particular output level. Each activity tries to achieve an indifference curve as far from its origin as possible. Success depends on political power, theoretically a reflection of social benefit offered. Institutions are devised to facilitate intergroup bargaining, permit expression of political (or dollar) support for allocation results of a particular welfare function, or permit expression of an alternative weighting scheme. Intergroup conflict suggests the bargaining process has failed--there is no point of indifference curve tangency between the specific water users. Institutions may be devised to create a satisfactory bargaining situation, by causing a polluter to bear the cost of pollution, encouraging the Corps of Engineers to consider conserving a reach of wild river, or a similar adjustment. Institutions may create a contract curve for competing users when no basis for bargaining exists. It would seem, for example, that the suggested revision of the evaluation procedures for

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[17] Allan Schmid, "Natural Resources and Growth: Towards a Non-Marginal Political Economics," Am. Jour. Agr. Econ. (Dec. 1969).

public projects is an institutional effort to create a bargaining situation between groups placing emphasis on water uses that strongly contribute to national income and groups more concerned with environmental quality, regional development and income distribution. Intergroup bargaining is not isolated from the "general will". Many components of the group welfare functions will be the same, an expression of Arrow's "moral imperatives". Differences of opinion occur primarily at the margin.

The absence of conflict does not mean that institutional arrangements are satisfactory. A powerful group may try to maintain prominence in the welfare function by limiting conflict. Public policy should not necessarily seek the path of least resistence in the political system. Readings in group behavior and political system theory suggest access is an essential ingredient in a pluralistic system as a mechanism for expression of support and definition of "public interest". Access is not uniformly available, and must be maintained by public institutions. Just as institutions have been devised to maintain the public interest with regard to competitors in the marketplace, so too must group interaction have guidance. Institutions must provide for effective consolidation of individual demands, while assuring that the full scope of the overall social welfare function is articulated.

Institutions and Federal Evaluation Procedures: We may now outline some ways that the above ideas on institutions relate to the proposed evaluation procedures.

1. There is much more to water management than federal project analysis. Management results from many decisions by many organizations, groups and agencies, guided by various institutions. If the Corps of Engineers had never come to the Susquehanna Basin, for example, water management would still take place--through the political system, and group bargaining. In any event, the assumption that the economics of water management begins and ends with evaluation of federal projects is misleading.

2. There is a need to continue efforts to measure project impacts. But we also need an understanding of the political use of these measurements--in many cases measurements may be pretty much beside the point. For example, the Sierra Club is not going to fold its tent just because a particular Corps of Engineers study shows low environmental quality benefits. And if any of us work for the Sierra Club, we will likely substantiate their position with "objective" data.

3. The economist's role need not be limited to that of a technician. In reality truly objective recommendations are unlikely, if possible, in a cardinal welfare sense. Data sources, measurement problems, etc. give the economist places to hide his opinions. He should recognize that he is part of the political process and not on some pedestal above it.[18]

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[18] As I. M. D. Little has said: "Rough theory, or good common sense, is, in practice, what we require. It is satisfying, and impressive,

4. The new procedures are a very important innovation--an institutional adjustment to demands by groups interested in things other than efficiency (better definition of the overall welfare function) but don't facilitate objective answers. The procedures provide a useful categorization of information for groups to use in their own calculations.

5. It seems that important institutional questions are not necessarily the structural combination of federal, state, and local units in planning but a strategy for assuring broad definition of the welfare function. Any number of structural alternatives may work, if the strategy is assured. This might call for bigger role for the states as the more decentralized unit.

6. The Corps of Engineers, Water Resources Council and other agencies are interest groups, or at least are indistinguishable from their clientele groups. Their welfare configuration has been pretty well institutionalized by government, in response to political support for development and construction. Their calculations will always reflect their political orientation, and authorized activities. Federal agencies should not apologize for their role in the political process but neither should analysts impute "absolute truth" to the calculations of the agencies.

7. The overall purpose of the federal use of these procedures should be to present as much information as possible, within the framework established.

8. The implication always seems to be that with considerable hard work and diligence and with our eyes clearly ahead and unswayed by greedy interest groups, we economists can develop a procedure for making predictable resource decisions, or at least presenting some perfect decision maker with a clear cut and measured definition of how a project influences our lives. That is a bit naive, but the effort is useful.

THE NATIONAL ECONOMIC EFFICIENCY ACCOUNT

Although the Flood Control Act of 1936 set forth a broad and ambiguous criterion for evaluation of proposed federal public works investments, in the past the statutory language has generally been interpreted to require that a national economic efficiency[19] analysis be undertaken

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that a rigorous logical system, with some apparent reality, should have been set up in the field of the social sciences; but we must not let ourselves be so impressed that we forget that its reality is obviously limited; and that the degree of such reality is a matter of judgement and opinion." I. M. D. Little, A Critique of Welfare Economics (Oxford University Press, 1957), p. 279.

[19] As Marglin has pointed out:

. . . economic efficiency as a concept for expressing the size of

as an aid to public decision-making on investment alternatives. As one of the key dimensions of the decision process, the national economic efficiency criterion, and the empirical method of benefit-cost analysis, has been the focus of sustained research and professional comment. Consequently, the theoretical and conceptual foundations of the analysis are well documented in numerous standard references and will not be repeated here.[20]

What will be attempted, however, is to formulate methodology for benefit and cost measurement which is consistent with underlying theory[21] and to show the necessary data needs for empirical investigation. Thus,

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> the economic pie . . . is superior to the concept of national income. The difficulty with national income is that it is too closely tied to market values. . . . if a water-resource development made great amounts of electrical energy available for residential consumers at low cost, it would add more to the size of the economic pie than another development scheme which made smaller amounts available at higher cost, even if the national-income value of the latter scheme measured at market prices were to be higher than the former. Such considerations have led economists to speak of the size of the economic pie in terms of a more fundamental principle, namely, economic efficiency.
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> Stephen A. Marglin, "Objectives of Water Resource Development" in A. Maass et al., Design of Water Resource Systems (Cambridge: Harvard University Press, 1962), p. 20.

Thus, although the Special Task Force speaks in terms of a national income account, we shall use the more generally accepted definition for to do otherwise leaves the analysis on a weaker conceptual basis. The argument is somewhat academic in any case since as a practical matter methods of benefit measurement which are generally used, and accepted by the Task Force, for benefit-cost analysis are based on the efficiency approach.

[20] Otto Eckstein, Water Resource Development: The Economics of Project Evaluation (Cambridge: Harvard University Press, 1958).

Roland N. McKean, Efficiency in Government Through Systems Analysis (New York: Wiley, 1958).

J. V. Krutilla and O. Eckstein, Multiple Purpose River Development: Studies in Applied Economic Analysis (Baltimore: Johns Hopkins Press, 1958).

Arthur Maass et al., Design of Water-Resource Systems: New Techniques for Relating Economic Objectives, Engineering Analysis and Governmental Planning (Cambridge: Harvard University Press, 1962).

Robert H. Haveman, Water Resource Investment and the Public Interest: An Analysis of Federal Expenditures in Ten Southern States (Nashville: Vanderbilt University Press, 1965).

[21] Broadening the decision-making framework to include multiple objectives does not change the theory underlying the economic efficiency criterion. Each criterion in a multiobjective welfare function is conceived of as being independent of the others and, thus, must stand on its own conceptual base.

consideration will not only be given to primary outputs and inputs but to changes in productivity, technological externalities, and multiplier effects, to the extent that they affect unemployed resources, due to the project. In the process, we will attempt to point out errors in current practices.

In an effort to make our task more manageable, we will discuss four general areas. First, the methodology and data needed to estimate benefits and disbenefits flowing from the primary outputs of a project. For example, the purposes of the Stonewall Jackson Reservoir proposal include provision of water supply, flood control, water quality and outdoor recreation. Each of these areas will be discussed in turn. Second, project effects which have not ordinarily been considered in previous benefit-cost work but which are conceptually part of any efficiency analysis will be discussed. These include the effects of the project on economic growth (productivity change), externalities, and unemployed and immobile resources. Third, considerations related to the estimation of project costs and cost allocation will be discussed. Finally, the analytical results of the various subsections will be used as data inputs for an economic efficiency analysis of the test project. In addition, the sensitivity of the resulting analysis to realistic adjustments of component variables will be shown and used as one means of handling risk and/or uncertainty factors.

Primary Project Purposes: Primary project purposes stem from the problems and needs of those potentially affected by the direct outputs of a project. In the case of the West Fork Basin, it is apparent that the initial request for an investigation of water resource development potential was spurred by considerations of flood damage. Ultimately, however, water quality, outdoor recreation, water supply and flood control all emerged as project purposes. The primary project effects (costs and benefits), from the standpoint of national economic efficiency, flow from these purposes and will be discussed in the following subsections. First, however, a discussion will be undertaken of the methods, consistent with economic theory, which can be utilized to quantify these impacts.

Methods of Impact Estimation: Normally, quantification of project costs presents less of a problem than quantification of project benefits. For use in an economic efficiency analysis, this type of impact is obtained from the market values required to purchase the goods and services to be used in project construction, operation and maintenance.[22] The accuracy of the techniques used to estimate these costs, however, is open to some question. Because this is an independent issue, it will be discussed in a later section. Emphasis here will be on positive and negative project benefits.

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[22]The type of cost items referred to here are only those which are paid for from the budget of the governmental unit for whom the efficiency analysis is being undertaken. This is in accordance with the commonly accepted practice of treating total federal cost as the critical part of the budget constraint for a federal project and treating all associated costs as negative benefits. See: Eckstein, 64-65.

Methods used for empirical estimation of primary benefits vary with the situation, type and nature of available alternatives, and type of good or service provided by the project under analysis. A number of methods have been suggested and used. However, the principal problems arise when attempting to place a monetary evaluation on nonmarket benefits. Thus, when the outputs of a governmental project compete directly with private sector alternatives the methods of evaluation are clear. Market prices (or alternative cost) should be used to approximate benefits if the increased output will not change prices markedly. To do otherwise could bias the analysis in favor of the governmental as opposed to the private market alternative. Normally, private market prices should be used when alternatives are technologically mutually exclusive and alternative costs when they are not or when monopoly market conditions prevail.[23] The alternative cost principal, as applied in the two latter situations, measures the value of released resources available for alternative uses. Care must be taken in using the alternative cost method, however, to insure that:

1. Long-run marginal rather average costs are used in the analysis;

2. Comparison of public and private alternatives are done under comparable bases of taxes, insurance and cost of capital;

3. "Least cost" and not the "most likely" alternative is used for comparison.

If the output of a governmental project competes with the private sector in fulfilling a given demand and, in the process, reduces market prices because of lumpiness in output, project costs should be subtracted from alternative costs to obtain the savings resulting from public investment, which will approximate the change in real national income. A number of dangers attend the use of this method, however. First, care must be taken not to count as a gain the cost of the cheapest alternative way of performing an unjustifiable task. Second, there is the danger of using reimbursement prices rather than actual costs which may be considerably higher. Third, marginal rather than average cost values should be used in the calculations. Fourth, there is the danger of making the cost comparison with a monopoly rather than free market price. Finally, care should be taken not to use decreasing cost functions in the calculations and, thus, inaccurately estimating the savings due to a public alternative.

In any case, the calculation of primary benefits from projects with private market alternatives is methodologically easier than when no private sector alternative exists or when the private sector alternative is one whose price is significantly influenced by governmental involvement.

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[23] Eckstein, 239-245
Maass, 192-222; esp. 215.

Under these circumstances and when the product or service under consideration is a consumer good with no indivisibilities in output, proxy market price or the willingness to pay for additional output is normally utilized to quantify the benefit figure. This method assumes small increments of product. In a situation where product output is a consumer good but indivisibilities of production are present, government action alone will cause changes in the proxy price. Since government is the major force in the market for the good under discussion, it can act as a discriminating monopolist and produce any quantity it deems appropriate. Thus, the average of the with and without prices or the consumer willingness to pay is normally utilized to quantify the value of output. In other words, the market value of the final product plus the consumer surplus is utilized. Finally, if goods are producer goods rather than consumer goods a different approach should be utilized. Since producer goods are not included in the accounting of the national income, double counting would occur if more than the increase in market value resulting from the project is included in the benefit value estimated. Thus, only the increased market value due to a project should be counted when calculating the benefit to the economy of output destined to be a producer good.

Obviously, the principal problem involved with estimating benefits from the output of governmental projects which do not have private market alternatives is the estimation of proxy demand functions. Because of the empirical difficulties, other courses of action have been suggested. The Task Force report recommends that one of two methods be utilized. First, "an estimate of the market valued benefits foregone by adoption of a plan to realize the nonmarket value benefits;" or second, "the cost of an alternative for obtaining the desired effects that would be undertaken in the absence of the project."[24] As Bromley and Beattie[25] have pointed out, the first method specifies that benefits will always equal costs and, therefore, no new information is obtained for use in decisions on resource allocation. The second method utilizes alternative costs without subtraction of project costs and, thus, does not give a net released cost or savings due to public investment. Therefore, the danger exists of always having benefits greater than or equal to costs since, if we make rational selections, we will choose the least expensive alternative and compare it with the second least expensive alternative. Neither method is a good substitute for the methods suggested previously which depend on transforming non-market commodities into a market context through the estimation of proxy demand functions. Both harm the intelligent application of the efficiency criterion in making investment decisions.

In light of the above discussion, it is interesting to note that benefit evaluation for the primary outputs of the proposed Stonewall Jackson Reservoir utilized the "alternative cost in the absence of pri-

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[24] Water Resources Council, Procedures for Evaluation . . ., 38.

[25] Daniel W. Bromley and Bruce R. Beattie, Testimony presented to the Water Resources Council Hearings, Washington, D. C., September 10, 1969, mimeo.

vate market alternatives" methodology for both water supply and quality benefits. However, an approximation of market value was used to evaluate flood control and recreation benefits. Using these methods and a 3 1/8% discount rate, the average annual primary benefits resulting from operation of the proposed reservoir were estimated at:

Flood control	$765,000
Water supply	82,000
Water quality control	1,001,000
Recreation	479,000
	$2,327,000

With this background we can proceed to discuss the specific methodology suggested by the Task Force for quantifying direct project impacts. We will consider each functional area separately and relate it to the evaluation of the Stonewall Jackson Reservoir.

Water Quality Impacts: Senate Document 97 suggested that water quality benefits be evaluated in terms of "avoidance of adverse effects which would accrue in the absence of water quality control . . ." It continued to state that "in situations when no adequate means can be devised to evaluate directly the economic effects of water quality improvement, the cost of achieving the same results by the most likely alternative may be used as an approximation of value." As indicated above, the latter approach is an objectionable method of calculating benefits from the standpoint of economic theory.

The Task Force recognizes this criticism. They state that: "Water quality is integrally associated with the uses, functions, and services obtained from water . . . That is, the quality aspect is a limiting factor in the uses to which it can be put or the services it can render." Thus, "any water quality component of any of the water categories should be incorporated in the particular water use involved. Water quality per se, such as reservoir storage under section 3-B of the Federal Water Pollution Control Act, to meet water quality standards, should be evaluated in the environmental account."[26] This recognizes that costs of meeting water quality standards, which are often set without being justified on an economic basis,[27] should not be included in the economic efficiency calcu-

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[26] Water Resources Council, Procedures for Evaluation. . ., 78 and 83.

[27] For an example of one means to determine standards based upon economic principals, see: Paul Davidson, F. Gerard Adams, and Joseph Seneca, "The Social Value of Water Recreation Facilities Resulting From An Improvement in Water Quality: The Delaware Estuary," in Water Research ed. by A. Kneese and S. Smith, Resources for the Future, Inc. (Baltimore: The Johns Hopkins Press, 1966).

lations since they are outside of the normal framework of the model. The standards are based more upon amenities and esthetics and are applied as "normative legal descriptions" rather than being based upon an economic justification. As the Task Force report points out:

> Any regulation of the flow of the water body will affect water quality for any of several uses to some extent. The effects on each use should be calculated according to changes in their pertinent quality dimensions or criteria. Favorable effects on any use should be ascribed as a benefit for that use. Benefits should not be ascribed to water quality per se. Therefore, any flow regulation . . . to serve a particular use must meet the quality requirements as well as the volume requirements for that use.
> Any favorable quality effects that occur incidental to regulation for other uses, such as from reservoir releases from navigation, power, water supply, and irrigation, should be ascribed as a benefit for the particular uses favorably affected.[28]

Thus, the Task Force report recommends that the traditional methods of estimating water quality benefits due to low-flow augmentation be substantially changed. Such a change flows directly from the theoretical foundation of an economic efficiency analysis and is an appropriate suggestion. Thus:

> The measure of the beneficial effects on each water use should reflect the extent to which the usefulness of the particular water use is affected. This measure may be in terms of savings in water treatment in the case of water supply or in terms of higher levels or degrees of water use for recreational waters.[29]

Therefore, the specific economic consequences of water quality improvement must be identified, shown to exceed primary benefits from the project output under consideration without the improvement and quantified before they can be added to primary benefits. In essence, an internalization of a technological externality must be identified as resulting from the project.

In the original study of the Stonewall Jackson Reservoir, the alternative cost of meeting water quality standards was utilized to determine the efficiency benefits from the water quality component of the project. The only alternative considered in this calculation was a smaller structural project for low-flow augmentation. This stems partially from the nature of the water quality problem in the basin. Although organic wastes are of some importance, the principal sources of pollution are acid mine drainage and hardness of the water below Clarksburg--which lies 38.9 miles downstream from the dam site. Alternative solutions to this type of problem are scarce and, if a practical solution does exist, many feel

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[28] Water Resources Council, Procedures for Evaluation. . ., 85.

[29] Ibid., 85-86.

the only one currently of general use is low flow augmentation.[30]

However, the measurement method is changed under the revised guidelines. The specific technological externalities resulting from water quality improvement must be identified and measured. For example, reduced corrosion damage, increased recreation or reduced water supply treatment costs are the types of impacts required if additional primary benefits resulting from water quality improvement are to be added to the functional benefits in the efficiency account.

The test team confirmed the Corps report that water quality was not a major problem between the dam site and the city of Clarksburg. The acidity problem develops downstream of Clarksburg.[31] Although the authorization report claims water quality benefits due to low-flow augmentation in the reach of the basin below Clarksburg, observation and conversations with experts in the area indicate that the project would have little effect upon water quality because of the relatively infinitesimal magnitude of the low-flow augmentation compared to what would be needed to improve water quality in the West Fork.[32] In addition, it appears from close observation that little economic benefit would be gained by improving water quality below Clarksburg. This stems from the lack of heavy industrial or municipal use of water in the area between Clarksburg and Fairmont.

The principal quality problems between the dam site and Clarksburg appear to be organic waste from raw sewage released to the river by the city of Weston. From the standpoint of economic efficiency, it is difficult to see how low flow regulation would improve water quality by providing a beneficial technological externality. Moreover, other alternatives, such as waste treatment plants which Weston does not presently have and which must be assumed in existence by section 3-b of the Federal Water Pollution Control Act before benefits from reservoir storage and flow regulation can be calculated,[33] would meet the need. Any improvement beyond this would be required to meet standards determined outside the efficiency framework and, thus, such effects should be included under the environmental account.

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[30] Corps of Engineers, West Fork River . . ., Appendix V. Other solutions to acid mine drainage problems are available but appear to lack the necessary volume requirements for a river like the West Fork. For example, see: Daniel C. McLean and Joseph A. Wernham, A Pilot Plant Study of the Autopurification of Sewage Effluent--Acid Mine Drainage Mixtures, Publ. No. 55, Institute for Research on Land and Water Resources, The Pennsylvania State Univ., June 1968.

[31] Corps of Engineers, West Fork River . . ., Appendix V.

[32] Telephone interview with experts at the University of West Virginia, Morgantown. Further evidence to support this view can be found in: Ibid.

[33] Federal Water Pollution Control Administration, Federal Water Pollution Control Act and the Oil Pollution Act, U. S. Govt. Printing Office, Washington, D. C., 1967.

The report of the Public Health Service on the West Fork[34] substantiates these conclusions. That report estimates the magnitude of any beneficial technological externalities of the project due to water quality improvement. Listed below are the estimated annual benefits in 2010 for specific categories of improved water quality:

Hardness reduction:		$ 39,000
West Fork River	$ 33,000	
Monongahela River	6,000	
Acidity reduction:[35]		10,800
West Fork River	Negligible	
Monongahela River	10,800	
Acid corrosion:		9,000
Water temperature control:[36]		11,000
		$ 69,800

The figures cited are drawn from a range of values given by the PHS which varied with the amount of discharge (cfs) from the proposed reservoir and the point on the time horizon for which the calculations were made. However, because the year 2010 was used, the benefits given tend to be higher than an average annual figure would have been. Also, when appropriate, the higher benefit values based on rate of discharge were chosen. Because of the small magnitudes involved, the ranges are not given nor was a sensitivity analysis for this component of the project

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[34] Corps of Engineers, West Fork River . . ., Appendix V.

[35] The low benefits asserted for acid reduction would appear to understate beneficial effects derived from increased recreation opportunities. However, the relatively small quality improvement would have little impact on the recreational use of the waters below the retaining structure. Perhaps of even greater importance are the conclusions of a recent Robert R. Nathan Associates study. They conclude that no economic basis exists for reducing water acidity in this region for purposes of increasing the supply of recreation facilities since acid free water areas will be abundant enough "to meet a greater proportion of the aggregate demand" in 1980 than they did in 1965. Moreover, they concluded that "human tolerance for acid polluted water, all other factors being equal, is probably higher than commonly believed." See: Robert R. Nathan Associates, Inc. "Impact of Mine Drainage on Recreation," Appendix E to Acid Mine Drainage in Appalachia (A Report to the Appalachian Regional Commission), June 1969.

[36] Does not account for future needs which this report assumes will be handled by other alternatives at the source.

deemed important. In view of the discussion in the previous paragraphs and because of the absence of any data on additional benefits from organic waste assimilation capacity, average annual benefits in this category were assumed to be zero.[37]

Thus, annual water quality benefits which increase the economic value of water use benefits stemming from the proposed West Fork project would approximate $69,800 for the efficiency account. This is an average annual reduction of $931,200 from the original report which use the alternative cost concept calculated at 3 1/8 percent interest. In general the Corps report states that minimum requirements for water quality control will be met by operation of the proposed reservoir. Minimum requirements, however, mean minimum standards and they do not appear, without more substantial data, to be grounded in economic need.[38] Moreover, as the Task Force has recommended economic efficiency benefits from water quality improvement should be associated with the "end use" of the water which received the benefit and not ascribed to an independent water quality account.[39] The nature of the benefits forthcoming from improved water quality identified the functional area of water supply as the primary beneficiary of such an improvement.[40] Therefore, the $69,800 of increased annual benefits due to quality improvement were placed under the category of water supply.

Outdoor Recreation Impacts: Estimation of efficiency benefits forthcoming from the public provision of outdoor recreational services has, in the past, entailed consideration of two factors. First, an estimate of the number of visitor days of recreation to be taken annually at the proposed facility during its economic life, and second, the assignment of simulated market values to the projected quantities of use in order to derive an estimate of total economic benefit. In theory, the quantity

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[37] In any case, it is obvious from an inspection of the area that the principal quality problems are not organic wastes but acid mine drainage.

[38] However, it is obvious that additional research and planning efforts need to be placed in this area. Efforts to improve our understanding of the interrelationship between changes in water quality and changes in primary benefits from outdoor recreation, water supply etc. must be undertaken to provide a more creditable basis for evaluation.

[39] It should be noted that this change has important implications for cost-sharing of federal project costs as determined by the separable cost-remaining benefits method. In essence, benefit categories, such as recreation, are required to bear increased portions of the total project cost (including costs for water storage designed to meet water quality standards under the environmental account) and, by so doing, may make a project unattractive for cost-sharing as required by statute.

[40] Acid corrosion reduction also has effects on navigation but because of the small magnitudes involved and the absence of a navigation component for the project this effect was allocated to water supply.

demanded and the market price or cost per unit are not independent.[41] However, the practice has been to follow the above procedure in the absence of a private market or more adequate simulation of proxy market conditions.

Supplement No. 1 of Senate Document 97 has added emphasis to this arbitrary and incorrect separation of quantity from price or value by setting guidelines for benefit valuation and use estimation without suggesting that adequate consideration be given to their interrelationship. In fact, no indication of what methodology is to be used for estimating potential use is given other than to list six factors affecting "the extent of total recreation use." Not one of the six mentions, directly, the cost of recreation as being important to total use.[42]

As Cicchetti et. al. pointed out, Senate Document 97 suggests that:

> After estimating the number of users for a particular recreation site, as best as one is capable of doing, ... a group of experts choose an acceptable price which when multiplied by the estimated quantity of users would determine total tangible benefits in dollar terms. This chosen price would be, of course, a measure of value in exchange, if the price chosen by the experts represents the true equilibrium price. The implicit rationale of this suggested approach appears to be that in the absence of empirical market price information, the planners are more able to estimate subjectively a single equilibrium price than to try to develop a complete demand curve. A demand schedule, the traditional device utilized in the economic analysis of total benefits, would, of course, provide a far superior measure of the value of alternative situations since total economic benefits are normally defined as the entire area under the demand schedule--the so-called value in use.[43]

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[41] Robert J. Kalter and Lois E. Gosse, Outdoor Recreation: Projections for 1970-1985, Special Cornell Series No. 5 (Ithaca: New York State College of Agriculture), Dec. 1969.

[42] U. S. Congress, Senate Document 97, 87th. Cong., 2nd Sess., Supplement No. 1, "Evaluation Standards for Primary Outdoor Recreation Benefits," June 4, 1964.

[43] Charles J. Cicchetti et. al. The Demand and Supply of Outdoor Recreation (New Brunswick, New Jersey: Bureau of Economic Research, Rutgers--The State University), March 1969, p. 7.

Value in use is defined as the total area under the demand curve. This corresponds to the definition of efficiency benefits given by Marglin in footnote 19 and suggested above for use in evaluation of governmental output for which their are no private market alternatives. Fundamentally, it permits valuation problems caused by price inelastic segments of the demand function to be resolved; whereas, Supplement No. 1 makes the indefensible assumption the price elasticity is always infinite for any

Using the methods suggested by Supplement No. 1, the average annual use and benefit values for the recreation component of the Stonewall Jackson Reservoir were calculated at:

Average annual visitation	375,600
Average annual benefits	$479,000

A unit value of $1.50 per recreation day was used in the calculations for general recreation, and values ranging from $0.60 to $1.85 per recreation day were used for fishing. However, due to staged development of the site and a projected expansion of demand over the project's time horizon, all the use, benefit, and cost values were converted to average annual figures using a 3 1/8 percent interest rate when appropriate.

As the Task Force implies and as was suggested above, the present guidelines for calculating the benefits forthcoming from the outdoor recreation component of a project are incorrect and inadequate. Rather what is needed is methodology which recognizes the interrelationships between price and quantity, and reduces the possibilities of double counting recreation demand when evaluating a project. Such double counting can take place if estimation methods are exclusively site oriented and fail to account for overall market demand and the competition for that demand from alternative sites. The Task Force recognized this point when they suggested:

> ...that a set of projections of recreation visitor days be developed on a comparable basis to the OBERS national, regional, economic area projects. The purpose of these projections would be to provide a framework for project analysis in order to estimate the project's reasonable share of regional and national recreation demand.[44]

Thus, demand schedules for both the proposed site and for the relevant market or population are needed. Research in both of these areas has been underway for some time and appears to be sufficiently developed to permit implementation in project planning and formulation studies. An example of the type of site oriented demand schedules which appear promising can be obtained from the research being funded by the Corps of Engineers out of the Sacramento District office.[45] National and regional

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size project. This, then, leads to a situation in project formulation where double counting or inaccurate projection of site demand is encouraged.

[44] Water Resources Council, Procedures for Evaluation..., 98.

[45] For a preliminary report on this research, see: V. S. Pankey and W. E. Johnston, Analysis of Recreational Use of Selected Reservoirs in California, Contract Report No. 1, Plan Formulation and Evaluation Studies--Recreation (U. S. Army Engineer District--Sacramento), May 1969.

market demand functions and associated demand forecasts have also been recently completed using nationwide household survey data.[46] These functions could be adapted to the needs suggested above. However, neither adequate time nor data were available to carry out this process on the Stonewall Jackson proposal. Therefore, the original estimate of recreation benefits was taken as a proxy for actual benefits, with no particular confidence being attached to it, so that the analysis could proceed.

In addition to suggesting that more adequate consideration be given to estimation of demand and economic value, our test suggested several other associated areas where problems could develop. First, the relationship between physical capacity and demand has often been ignored and should be explicitly introduced into the analysis. For example, although forecasts forthcoming from a demand function for the site may be compatible with market demand, planned physical capacity may not be adequate to accommodate that demand. The use of generalized recreation production functions is needed to insure consistency in this area as well as providing more adequate information on input substitution rates so that more optimum resource allocation can occur.

Second, care must be taken to project net increases in demand resulting from a project. Thus, subtraction of the value of recreation to be expected without the project, and not including losses foregone (due to, say, replacement of wildlife areas) as benefits, is a necessary part of any estimation methodology.

Finally, benefits resulting from associated facilities which are constructed with funds not considered part of the budget constraint of the federal agency involved should not be considered as related to the project being analyzed. To do otherwise leads to a never ending chain of "development" benefits which supposedly are a direct result of the project but for which the "with-without" test has not been rigorously applied. More will be said about this later when we discuss multiplier and expansion effects, but it should be noted that this is of special concern here since the State of West Virginia plans to construct, out of its own budget, additional recreation facilities at the project site. One can only ignore this type of effect in an analysis because of the unproven linkage. But more to the point, in this case, if one assumes that the State will spend the same amount of funds on similar facilities with similar impacts somewhere in the State, no net gain is obtained.

Water Supply Impacts: Senate Document 97 suggested that water supply benefits be based on the "amount water users should be willing to pay for such improvements." This implies the need for proxy demand functions like those suggested for estimating outdoor recreation benefits and use. However, Senate Document 97 went on to say that: "In practice,

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[46] Robert J. Kalter and Lois E. Gosse, Outdoor Recreation: Projections for 1970-1985.

Charles J. Cicchetti, et. al., The Demand and Supply of Outdoor Recreation.

..., the measure of the benefit will be approximated by the cost of achieving the same results by the most likely alternative means that would be utilized in the absence of the project." The Task Force appears to accept either the willingness to pay or alternative cost measurement technique, but indicates that a possible proxy for willingness to pay would be the "costs of raw water" from recently developed projects in the region.

Proxy demand functions for water supply would provide a better approximation of the theoretical value of water in this use. Alternative costs techniques suffer from the same problems indicated previously. However, because the water supply component of a federal project is subject to 100 percent local reimbursement based upon the separable costs-remaining benefits method of cost allocation, use of alternative cost techniques may provide an acceptable approach to measurement of water supply benefits. Therefore, in the absence of proxy demand functions or other means of evaluating willingness to pay, the original estimate of $122,100 of annual water supply benefits was retained for use in this report.[47] In addition, the benefit values for water quality improvement ($69,800) were added to this account because they resulted in an increased value of this "end use."

The limits placed on this report, however, forced us to utilize this less than satisfactory solution and ignore, perhaps, the most interesting issues concerning water supply. The Water Resources Council should be urged to investigate, on a regional basis, the price and income elasticity of water use and possible implications of various levels of public pricing on the publicly determined supply function and the consideration of alternatives.[48]

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[47] It should be noted that this value was calculated at a 4 7/8 percent interest rate and this results in an increase in the annual benefit value of $82,000 used in the original report.

[48] For examples of the type of demand studies which are necessary see: James E. Ware and Ronald M. North, The Price and Consumption of Water for Residential Use in Georgia, Research Paper No. 40 (Atlanta, Georgia: Bureau of Business and Economic Research, School of Business Administration, Georgia State College), Oct. 1967.

Delworth Gardner and Seth Schick, Factors Affecting Consumption of Urban Household Water in Northern Utah, Bulletin 449 (Logan, Utah: Utah Agricultural Experiment Station).

J. C. Headley, "The Relation of Family Income and Use of Water for Residential and Commercial Purposes in the San Francisco-Oakland Metropolitan Area," Land Economics, Vol. 39, Nov. 1963, pp. 441-449.

Manuel Gottlieb, "Urban Domestic Demand for Water: A Kansas Case Study," Land Economics, Vol. 39, May 1963, pp. 204-210.

Dorothy Dunn and Thurston Larson, "Relationship of Domestic Water Use to Assessed Valuation, with Selected Demographic and Socio-Economic Variables," Journal American Water Works Association, Vol. 55, April 1963, pp. 441-450.

Flood Control Impacts: Traditionally flood control benefits have included the reduction in property and crop damages, improvements in the productivity of land and property, and reductions in indirect production losses due to flood protection. The Task Force accepts these potential benefit areas and discusses some factors complicating their measurement but provides little guidance on improved measurement methodology. Because of the well documented problems centering around flood plain definition, estimation of future stream hydrology, estimation of future flood plain development without the project and impacts of institutional changes like flood plain zoning,[49] the Water Resources Council should recommend that additional research be centered on these areas in order to reduce the uncertainty associated with primary flood control benefit forecasts. For lack of improved data in these areas, however, the estimate of $765,000 in annual flood control benefits, founded in the Corps' report on the Stonewall Jackson Reservoir, was utilized.

Other Project Effects: Theoretically the economic efficiency benefits of a project consists not only of a willingness to pay measure of direct project outputs but also include income impacts resulting from productivity changes caused by the project, employment of unemployed or immobile labor because of the project, and/or technological externalities caused or changed by the project. However, these latter effects, both positive and negative, can easily be ignored or assumed away, in whole or part, as unimportant if methodology is not specifically structured to consider them. Too often this has been the case in the real world of applied analysis. In other instances only certain elements of these factors are considered and the result is an uneven and capricious handling of several potentially important areas. For example, in the case of Stonewall Jackson Reservoir, the expected productivity change of land and property on the flood plain was included in the analysis of flood control benefits but the effects of water supply or its quality improvement component on productivity were not considered. Likewise, the increased recreational usage of the waterway due to water quality improvement (a technological externality) was considered for inclusion as an efficiency benefit but the impacts of increased recreation visitation on unemployed labor were ignored. The actual importance of such factors is an empirical and not a theoretical question and, therefore, they should be considered as part of every economic efficiency analysis.

The Task Force considers these often neglected areas under a heading entitled "Secondary National Income Benefits."[50] Under this title, two

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Charles Howe and F. P. Linaweaver, "The Impact of Price and Residential Water Demand and Its Relation to System Design and Price Structure," Water Resources Research, Vol. 3, First Quarter 1967, pp. 13-32.

Joe Bain, Richard Caves and Robert Margolis, Northern California's Water Industry (Baltimore: Johns Hopkins Press, 1966).

[49] For example see: Eckstein, Ch. V.

Robert H. Haveman, "Ex Post Performance Evaluation: The Case of Flood Control," unpublished paper.

[50] Water Resources Council, Procedures for Evaluation . . ., 100-111.

general areas which are not mutually exclusive are discussed. First, the existence of project impacts which result from "use externalities" or situations where there "exist economies of scale in production for industries affected by the project output" are considered. The report goes on to state: "Under this condition production units may be operated at a more efficient level or interrelated processes may be better coordinated including the elimination of bottlenecks to the efficient expansion of other activities." In other words, returns to scale which occur with as opposed to without the project are viewed as one area which has often been neglected in previous evaluations. Second, reduced "resource immobilities," in the form of otherwise unemployed or underemployed resources which are utilized to a better advantage "as a result of the developments occasioned by the project," are considered. The Task Force concludes that this latter type of impact could come about through either project construction and operation or through expansion of industries directly or indirectly using project outputs. In both cases, the Task Force limits the consideration of the so-called "secondary national income benefits" to situations in the "area or region to be effected by the project." This, however, should be considered only an analytical convenience and not a theoretical requirement because real national income multiplier effects of a project can occur throughout the economy even though the region of initial primary impact would not generate them.[51]

The analysis of project effects on returns to scale and resource immobilities, as outlined by the Task Force, has a number of conceptual and empirical problems, however. First, under the "use externalities" section, the report appears to confuse returns to scale (a long run concept which relates to proportional changes in the quantities of all factors employed in the production function and not to a change in the proportion of factor employment), returns to outlay (a concept which permits changes in proportions among inputs in either the short or long run), and productivity change (a concept where proportions among inputs change in either the long or short run due to a change in technology). Only the former (where it results from a technological externality associated with provision of water services) and the latter (a special case of returns to outlay) should be considered as important to real changes in economic efficiency since price changes can cause changes in returns to outlay and these are merely transfers. Moreover, the technological change which results in a productivity impact would need to stem directly from the project under analysis rather than the industry using water services. Regardless of the exact circumstances of production, if one is considering the impacts of a water project, the industry demand functions for firms using water services must either be

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Although the Task Force implies that only benefits would result, it is obvious that both positive and negative impacts should be considered.

[51] R. H. Haveman and J. V. Krutilla, Unemployment, Idle Capacity and the Evaluation of Public Expenditures: National and Regional Analyses (Baltimore: Johns Hopkins Press, 1968).

assumed perfectly price and income elastic or of known elasticity before an increase in national income can be ascribed to a reduction in a water constraint. In fact, depending on the market structure of the industry and the elasticity of the demand function, a net reduction in industry revenue could occur. The assumption of perfectly elastic demand for industry output is unrealistic, however, and the empirical problems involved in determining the shape of demand functions for specific industries are such that this type of sub-analysis should be considered only if a strong a priori case can be made that shortages of water services act as a constraint on more optimal production or that a water project will bring about technological change. Evidence indicates that availability of water services is seldom an important factor in the costs of production for most industries.[52] These factors along with the nature of the water using industries on the West Fork, the availability of water, and the traditional nature of the proposed project (no technological innovation) dictated against analyzing the test project for "use externalities."

Second, the terms "resource unemployment or underemployment," as used by the Task Force, need further clarification. There is no resource that cannot be put to some "higher use" given effective demand. Focusing on unemployed labor, as the Task Force seems to do, results in some clarification, in view of the macro-economic value judgements society has made about unemployment, and reduces the amount of subjective judgement needed.

Third, in view of the essentially permissive nature of water resources in the regional growth process, it is difficult, if not impossible to prove any link between social overhead capital in the form of water resource development and the improved competitive situation and expansion of water service using industries, with a resultant effect on unemployed labor resources.[53] Too many other factors are not only necessary but required at predetermined levels (water is usually not) to be able to ascribe reduced labor unemployment solely or partially to the effect of water development on industry growth. Moreover, an improvement in the competitive situation of regional industries may not result in a net national income gain. Again, industry demand functions would be needed and the interregional tradeoffs quantified unless the impact is totally regional due to labor immobility.

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[52] H. R. Hamilton et. al. Systems Simulation for Regional Analysis: An Application to River Basin Planning (Cambridge: M. I. T. Press, 1969).

[53] David J. Allee, "Place of Water Resources Planning in Economic Regional Development," In The Fresh Water of New York State: Its Conservation and Uses, L. B. Hitchcock, ed. (Dubuque, Iowa: Wm. C. Brown Book Co., 1967), pp. 170-180.

Emery N. Castle and Russell C. Youmans, "Economics in Regional Water Research and Policy," Am. Jour. Agr. Econ., Vol. 50, No. 5, Dec. 1968, pp. 1655-1666.

Acceptance of the above proposition would suggest that both of the approaches, suggested by the Task Force, to measure "national income secondary benefits"[54] be rejected in the case where a proposed project is assumed to have impacts on labor unemployment and immobility through expansion of industries directly or indirectly using project outputs. Regardless of the merits of either approach for the measurement of related types of effects, the inability to separate joint effects, the permissive role of water in growth, the broad ability for technical substitution, and the large degree of uncertainty connected with forecasts of human resources immobilities[55] argues that the such impacts are generally small and always nearly impossible to separate and measure.

Fourth, water resource projects tend to be an unreliable and inefficient means of reducing labor immobility and unemployment, either directly or indirectly, because of the time lags which exist between planning, construction and operation,[56] and because of the relatively low levels of resources required for operation. However, the degree of uncertainty associated with the necessary forecasts is substantially reduced when considering only the impacts of the project itself on labor unemployment. In light of this and the other points mentioned above, no more than a calculation of unemployed labor resources put to work as

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[54]The first approach proceeds from "establishing the total achievable level of national income secondary benefits that may be forthcoming from an economic area from all forms of developmental investments and establishing the role and contribution of a specific water resources project therein." The second approach is "simply to build upon the effects of a specific water resources project and other developmental investments that may be required to determine the secondary benefits in the presence of otherwise immobile resources." Water Resources Council, Procedures for Evaluation . . ., 107.

[55]Because it is the explicit policy of governmental units to reduce the rate of labor unemployment and increase mobility, numerous exogenous factors can and will influence such forecasts. The OBERS (Office of Business Economics and Economic Research Service) economic projections reflect this fact in the numerous and restrictive assumptions which underlie them. An assumption as basic as that on population growth could have drastic effects on the final forecasts. Yet no range of results based upon varying assumptions is given for consideration and, therefore, the ability to isolate important assumptions for further study is unavailable. For these reasons and because of their macro orientation, the OBERS economic projections were found to be little aid in the analysis of specific project proposals. Projections of the severity and extent of labor unemployment, based upon a range of OBERS forecasts, would have been helpful to the evaluation of resource immobilities but were not available.

[56]Julius Margolis, "Public Works and Economic Stability," Journal of Political Economy, LVII (Aug. 1949), pp. 293-303.

a direct and indirect result of the construction, operation and maintenance of a water resource project is justified. Thus, the multiplier effects of project construction and operation on unemployed labor, as well as the direct effects, should be accounted for if unemployed labor resources exist in the nation. However, possible effects of project outputs on the expansion of other industries and the resultant direct and indirect effects should not be calculated for the reasons cited above. Moreover, care must be taken to ascertain the regional origin of labor directly employed at the project site and, in light of this, to determine the actual extent of unemployment reduction. Not to consider this factor opens the possibility of merely transferring already employed resources to the region of the project. This is equally true but more difficult to quantify for any multiplier impacts which occur. Although it does not consider this transfer question adequately, the most well developed methodology for calculating the national and regional indirect or multiplier impacts of a project on unemployed labor resources is the recent study of Haveman and Krutilla.[57] Direct impacts must be estimated separately.

Because of its location in the Appalachia region, the proposed Stonewall Jackson project was analyzed for its "area redevelopment benefits" in the Corps' study report. This analysis corresponds in substantial degree to the framework suggested for analysis by this study. The employment benefits were determined on the basis of "wages paid to persons employed during construction and operation of the project who would otherwise be unemployed, when these wages are paid to persons recruited from local areas classified as economically depressed."[58] However, no indirect or multiplier effects of the project on unemployed labor in either the region or nation were calculated. Due to the relatively low national unemployment rate which has been maintained up until recently, this would probably not have been of importance to the overall estimation of benefits. Recently even unemployment levels in the project area have been reduced to frictional rates although the State of West Virginia remains at close to a seven percent unemployment rate.[59] Although these factors may have caused an underestimate of the employment benefits, several other aspects of the Corps methodology could have lead to an overestimate. For example, both federal and non-federal costs were included in the calculations, when it is safe to assume that, in the absence of the project, local expenditures would have been used for other purposes with no resulting net gain (except to the extent that the mix of employment effects would have differed). Moreover, no empirical varification of the assumptions concerning regional origin of the labor component were made nor can it be assumed, as the report appears to do, that existence of unemployed labor of specific required skills in the region of construction is tantamount to its being put

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[57] Haveman and Krutilla.

[58] Corps of Engineers, West Fork River . . ., Appendix X.

[59] State of West Virginia, Labor Market Digest (periodic).

to work.[60] Likewise, the assumption, for both construction and operation, that unemployed labor would be utilized before intra- and inter-region transfers appears based on highly unrealistic assumptions. Finally, both the assumed time horizon for the impacts (twenty years) and the assumption that, regardless of skill, all labor received comparable wages appears unrealistic in the light of actual experience. Obviously, additional research efforts need to be placed on these questions. However, because the estimation errors appear to be partially offsetting and for lack of more of the detailed data required, the Corps estimate of $137,000 in equivalent average annual employment benefits over the 100-year life of the project were accepted.[61] One other point of some importance (especially for projects which bulk relatively large in a region's economy during construction) which was not considered here for lack of data is the disruptive effects on the local economy of rapid labor inflows and outflows during the period of construction. This type of negative impact along with the possible seasonality of certain industries, such as recreation, which are associated with water resource developments should be recognized and accounted for in future evaluations.

Project Costs: As indicated in the introductory portion of this discussion on the national economic efficiency account, the federal capital, operating, maintenance and repair costs associated with water resource investments are conceptually and empirically easier to quantify for evaluation than project benefits. All that is required is an estimate of the market prices of the goods and services to be utilized by the project proposal. Yet, ex post studies have indicated that a wide deviation often occurs between survey cost estimates and actual costs.[62] The reasons

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[60] Especially important here is the fact that the unemployment base was estimated for the month of March (a traditionally high unemployment month for construction) and does not appear to be realistic when applied to actual months of peak construction activity.

[61] It should be noted that although conversion of the twenty year time horizon of employment benefits to a present value and then amortizing this figure over the 100 year project time horizon will lead to the correct mathematical result, it leads to a grossly misleading display of actual project benefits. The unaware can easily be lead to believe that such impacts occur in a constant annual amount over the 100 year time horizon of the project when, in fact, the major impact occurs during the construction phase of the project only.

[62] For example, see: Maynard M. Hufschmidt and Jacques Gerin, "Systematic Errors in Cost Estimates for Public Investment Projects," paper presented at a Universities - National Bureau of Economic Research Conference on the Economics of Public Output, April 26-27, 1968.

U. S. Congress, House of Representatives, Committee on Public Works, The Civil Functions Program of the Corps of Engineers, United States Army, Report to the Committee on Public Works, House of Representatives, by Mr. Jones of Alabama from the Subcommittee to Study Civil Works, Eighty-Second Congress, Second Session, December 5, 1952, House Committee Print No. 21.

for such deviations, both positive and negative, vary but generally included components of inflation, project modification and simple mis-estimation of project requirements. After an extensive investigation of the cost estimation problem, Haveman concluded that the "Corps cost estimation procedure is characterized by a significant inconsistency in achieving accurate cost estimates for individual water resource projects."[63] His analysis, based upon real rather than money costs, indicates that many of the estimation errors are offsetting and, therefore, ex ante estimates of overall program costs have a high degree of accuracy. This is of little consequence, however, to the economic evaluation of individual projects. In the absence of more accurate cost data or estimation techniques, experience creates a strong arguement for a sensitivity analysis of a project's cost estimate as one means of allowing for risk and uncertainty. This will be carried out at the end of this section for the proposed Stonewall Jackson Reservoir by using the Corps initial capital cost estimate of $35,936,000 as the reference point.[64]

Although problems of cost estimation were not raised in the Task Force report, another issue related to project costs was. That was the report's directive concerning allocation of costs among objectives. This issue has been adequately discussed elsewhere[65] but a portion of this is repeated below for purposes of clarity.

> The Task Force indicates on page 29 that: "... benefits and costs have meaning only to the extent that they can be related to objectives..." In view of their recommendation on multiple objectives, they state that the need emerges "to make explicit the evaluation principle of relating benefits to objectives." However, on page 31, the report goes on to point out that the objectives "are not mutually exclusive accounts since benefits that would be assigned to each cannot be added to a grand total of benefits." All of these statements are well taken since projects produce national income gains as well as benefits attributable to other objectives like regional growth and environmental quality. Furthermore, benefits which are counted under

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Office of the Chief of Engineers, Headquarters, Department of the Army "Engineering and Design, Project Cost Estimating - Civil Works," Engineer-Circular No. 110-2-1301, February 3, 1965.

[63] Robert H. Haveman, "Ex Post Performance Evaluation: The Estimation of Project Costs," unpublished paper.

[64] Haveman's analysis indicated that the mean percent deviation of the estimated from realized cost was 14 percent for multi-purpose projects. To the extent that this was not due to project modification, it can provide a guide for sensitivity testing. Ibid.

[65] Robert J. Kalter et. al., Criteria for Evaluation of Resource Investments.

Robert J. Kalter, Testimony Presented to the Water Resources Council Hearings, Washington, D. C., September 10, 1969, mimeo.

one criterion framework may also be applicable to other objectives. For example, certain national income gains of a project can also be gains to a region and should be accounted for under both objectives. Although a given dollar volume of benefits would be counted twice in this case, it is not double counting in the traditional sense because of the conceptual difference in objectives and the resulting fact that benefits accruing to the two accounts cannot be added together to give a "grand total."

The same argument holds true for the cost side of the accounting frameworks. However, the Task Force does not follow this line of reasoning. On page 57 they state:

> "The Task Force proposes that national income and other costs required to realize the benefits contributing to a given objective be assigned to that objective under column (2) or (3) of the table. When a plan formulated for maximum net national income is modified to achieve another objective it is proposed that the incremental costs be assigned to the other objective. If the increment also results in additional national income gains these would be entered in the national income account with the reassignment of an equivalent amount of the costs of the increment. Thus, an equal amount would be reassigned to both benefits and costs in the national income account and the benefit-cost ratio in the modified national income account would be a measure of the return in that account. The system would reveal the cost in national income terms of achieving the other objectives."

... However, to follow this suggestion would destroy the conceptual foundation upon which the analysis of individual objectives rests. All proposed projects will have implications for all of the various objectives. Therefore, project analysis should show the effect of the project on each of the objectives. This can not be accomplished if the Task Force recommendations are carried out. For example, if costs properly included under the national efficiency framework are allocated to other objectives because a project has implications for those objectives, the meaning of the national efficiency analysis would be destroyed. This can be illustrated by a hypothetical example. If a proposed river basin project had a projected present value national efficiency benefit of $100 and a projected present value national efficiency cost of $50, the benefit-cost ratio would be 2.0 and the net present value efficiency benefits would be $50. For simplicity we will assume no benefits to the regional or other objective accounts. Now assume that an increment of $25 in national efficiency costs is added to the original proposal for the sole purpose of providing a regional benefit. Further, assume that the actual result of that addition produced $50 of present value regional benefits but no benefits to other objectives, including national efficiency. The modified plan is in actuality a different alternative from the original plan. It would have

> the same national efficiency benefits but a $75 national efficiency cost. The result is a benefit-cost ratio of 1.33 and $25 of net present value efficiency benefits. However, in addition, $50 of regional benefits are obtained at a zero cost to the region [except for their share of taxes] and a $25 cost to the nation. The tradeoffs between the two alternatives are made explicit.
>
> If the Task Force recommendations are followed, however, the results of the national efficiency analysis will not differ between the two alternatives--i.e., both would show a 2.0 ratio and $50 of net benefits. This is obviously not the case because all national costs are not included for the second alternative. Furthermore, the analysis does not show "the cost in national income terms of achieving other objectives." The latter is also a stated goal of the Task Force recommendations but carrying out their recommendations on cost allocation would make it impossible to accomplish as well as rendering the analysis shown in the national efficiency account meaningless.[66]

Therefore, the Task Force should reject its initial directive that total project costs be allocated among the various accounts in accordance with the proportion of costs required to meet specific objectives. Aside from leading to arbitrary and capricious allocation methods, this guideline destroys the conceptual foundation of the various accounts and does not permit tradeoffs between objectives to be displayed quantitatively.

Economic Efficiency Evaluation of the Proposed Stonewall Jackson Reservoir: The results of the previous discussion and analysis, as applied to the proposal for the West Fork River, can now be brought together and summarized through the use of techniques design to measure the economic efficiency of project proposals. The data to be used in this analysis are summarized in Table 1. With a discount rate of 4 7/8 percent and a time horizon of 100 years, the following results were derived:

B/C ratio = 0.75

B-C = - $9,533,165

Rate of Return (internal) = 3.5%

O/K Ratio = .00455 (ratio of annual to fixed costs)

Thus, the project is economically unjustified from a national efficiency point of view by all measures[67] used here, depending of course on the

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[66] Robert J. Kalter, Testimony.

[67] For a detailed discussion of the differences between the three criterion forms, see: Otto Eckstein, Water Resource Development: The Economics of Project Evaluation (Cambridge: Harvard University Press, 1958), ch. III.

TABLE 1

BENEFIT-COST DATA FOR STONEWALL JACKSON RESERVOIR

Initial Investment	
First Cost	$33,486,000[a]
Interest During Construction @ 4 7/8 %	2,450,000
Total	$35,936,000
Average Annual Charges	
Interest (4 7/8%)	$ 1,752,000
Amortization (100 yr. life)	31,800
Operation and Maintenance	146,700
Major Replacements	17,000
Total	$ 1,947,500
Average Annual Benefits	
Recreation	$ 479,000
Water Supply	191,900
Flood Control	765,000
Employment Benefits	137,000
Sub-Total	$ 1,572,900
Adjustment for net loss of productivity on land	-111,000[b]
Total	$ 1,461,900

[a]Partially based upon cost of initial development of recreation facilities and discounted costs of future recreation developments.

[b]Placed as a negative benefit because it is not part of the federal cost constraint. The original Corps report included this item as part of annual costs.

Source: Senate Document No. 109, 89th Congress, 2nd Session. Data modified as noted in previous discussion and by using 4 7/8 percent interest rate when appropriate.

interest rate used to determine the marginal internal rate of return. If capital costs were 4 7/8 percent, for example, a return of 3.5 percent could not be justified.

The results of such an economic feasibility study, however, can be tested for their sensitivity to adjustments in the various parameters and value determinations integral to the conclusions of the analysis. For example, the methods used to measure benefits and costs, and the use of differing time horizons and discount rates can all produce a range of possible results from a national economic efficiency analysis. Normal conditions of risk and/or uncertainty can account for such a range in actual practice and one available method of handling such factors in a

pre-construction analysis is to perform a sensitivity analysis. Then alternative results can be compared with both the realism of the assumptions and the magnitude of the impacts forthcoming from the use of these assumptions.

A number of possible adjustments and combinations of adjustments could be carried out. However, rather than a detailed analysis of each functional component, only two gross modifications of the Stonewall Jackson base line data will be made.[68] This will serve to highlight the possibilities of a sensitivity analysis and the need to think in terms of a range of results. At the same time, it will not over complicate the display of results need for this test. The two data modifications will include a ten percent increase and decrease in the project capital costs[69] and a similar change in project benefits. The latter is based upon a conservative a priori judgement concerning the uncertainty of forecast results associated with the techniques used for measurement of recreation benefits and water quality improvement impacts. Thus, eight possible combinations of results, which differ from those derived from the reference data, will be calculated. No changes were made in the rate used for discounting or the time horizon of the analysis. The former has been sufficiently institutionalized to be taken as an appropriate indication of the social rate of time preference while variation in the latter, given the present discount rate, would not effect the analytical results to a significant degree if it is not lowered below fifty years. This results from the low present values of those portions of the benefit or cost time streams which occur after fifty years when discounted at current rates. The results of the sensitivity test are shown in Table 2.

The sensitivity test did not change the initial conclusion that the proposed Stonewall Jackson project was economically unjustified. Thus, more confidence can be placed in the results, provided one accepts the underlying measurement methods and assumptions. Moreover analysis using the discount rate expected to be authorized in the coming fiscal year (5 1/8%) would have fortified the conclusion.

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[68] For a more complete sensitivity analysis of a project, see: L. W. Libby and R. J. Kalter, Critique of the Economic Justification of the Genessee River Project at Portageville, New York, A. E. Res. 264, Department of Agricultural Economics, Cornell Univ., Oct. 1968.

[69] See footnote 64, page 28, for the rationale behind this adjustment.

TABLE 2

CRITERION SENSITIVITY TO CHANGES IN
INITIAL INVESTMENT AND ANNUAL BENEFITS

Annual Benefits	Initial Investment	Economic Measures[a]			
		B/C	B-C ($1,000)	R of R (percent)	O/K
Original	Original	0.75	$-9,533	3.5	.0046
Original	10% Inc.	0.69	-13,127	3.1	.0041
Original	10% Dec.	0.83	-5,940	3.9	.0051
10% Inc.	Original	0.83	-6,960	3.9	.0046
10% Dec.	Original	0.68	-12,506	3.0	.0046
10% Inc.	10% Inc.	0.76	-10,154	3.5	.0041
10% Inc.	10% Dec.	0.92	-2,966	4.4	.0051
10% Dec.	10% Inc.	0.62	-16,100	2.7	.0041
10% Dec.	10% Dec.	0.75	-8,913	3.4	.0051

[a]Calculations based on 100 year time horizon and 4 7/8 percent discount rate.

THE WELL-BEING ACCOUNT

The Task Force stated that the well-being objectives were to "consider the personal, group, and community effects of the project or program activity. Since some of these well-being objectives have a locational impact, there is a close relation to regional development objectives. Included are such objectives as security of life and health, national defense, personal income distribution, and inter-regional employment and population distribution."[70] However, in an effort to specify the bounds of this account more concretely so that quantitative analysis could be carried out, the test team decided to restrict the analysis undertaken to considerations of personal income distribution. This type of effect has previously been ignored in the economic analysis of water resource investments, yet appears to be an important part of the decision makers objective function.[71]

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[70]Water Resources Council, Procedures for Evaluation..., 24.

[71]Arthur Maass, "Benefit-Cost Analysis: Its Relevancy to Public Investment Decisions," Quarterly Journal of Economics, LXXIX (May, 1966) pp. 208-226.

Moreover, the personal income distribution aspect was the only component suggested for consideration under the well-being objective which was both susceptible to economic analysis and at the same time not considered as part of the other three accounts. For example, national defense objectives have always been removed from the economic efficiency framework and analyzed through cost-effectiveness procedures. Security of life and health is subject to quantification in monetary terms and, therefore, can be made part of either an economic efficiency or equity analysis. Therefore restriction of the analysis to questions of personal income equity would appear to be based upon a logical set of assumptions.

General Procedures: Income is redistributed by federal water resource investments whenever the distribution of net benefits is nonproportional to the original income distribution.[72] In order to determine the magnitude of the net benefit accruing to an income class, the benefits received by that class are defined as a portion of total project benefits.[73] The costs born by each income class are defined to include a portion of the indirect payment, via taxation, of total investment and operating costs of the project, and any direct payments for benefits received.[74] Then, the total cost is netted against the total benefits to each class, and the resulting net benefit distribution is compared to the initial income distribution.

The Model: If the benefits to an income class accrue to that class in the absence of reimbursement,[75] the net benefit can be il-

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B. A. Weisbrod, "Income Distribution Effects and Benefit-Cost Analysis," in S. B. Chase, ed., Problems in Public Expenditure Analysis (Washington: The Brookings Institution, 1968).

[72]The term "redistribution" is used here to denote a comparison between an initial or reference income distribution and the distribution of project net benefits. Thus, it refers to a flow and not to the redistribution of a stock.

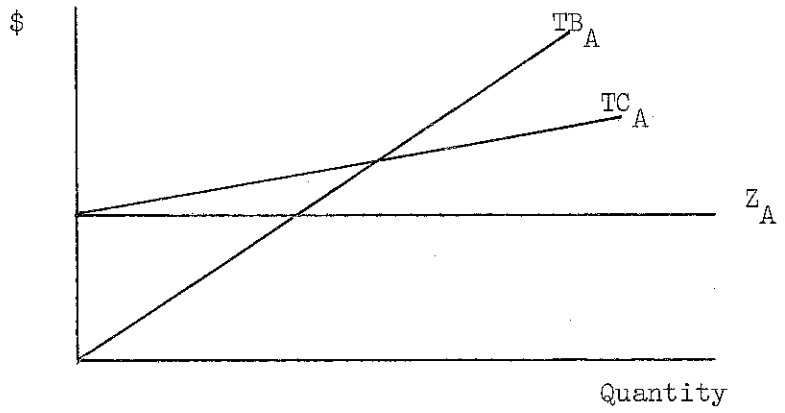
[73]If the analysis takes a national view point, total project benefits would correspond with national efficiency benefits. A regional analysis, however, would consider the total regional benefit of a project including the appropriate transfers. For a further discussion of this point see the following section on the regional account.

[74]If the relative impact of a project on income distribution is of major concern, reimbursement is not a complicating factor and the budget constraint is fixed, the cost side of the distribution account will be fixed and will not affect the net. Thus, only the distribution of benefits is required. If, however, the absolute impacts are of concern, reimbursement is required and/or the budget constraint is flexible and depends on project evaluation, the cost side of the account must be quantified.

[75]The term "reimbursement" refers to the partial or total repayment of project costs, or, alternatively, payment for benefits received as a result of a project. For example, if the federal government provides the initial funds for the construction of a project but these funds must be repaid, reimbursement is said to occur.

lustrated by Figure 1. Z_A represents the portion of the tax payment by

FIGURE 1



income class A which is allocated to the construction of a project. The benefit of the project to the class is represented by TB_A. TC_A is the total cost to class A and includes Z_A plus income class A's portion of annual operating and maintenance costs. The net benefit to class A is measured as the difference between TB_A and TC_A. It may be positive or negative depending upon the quantity of units, Q, purchased or consumed. TB_A and TC_A may be represented as curvilinear functions, especially in the case of a producer's good where TB_A becomes a total value product curve.

However, the benefits or costs other than the initial tax, Z, accrue to the income classes over time, and a discounting procedure is necessary to place them on a present value basis. Therefore, the conceptual model is more completely expressed in mathematical form.

$$(1) \quad TB_A = \sum_{t=1}^{T} \frac{B_{At}}{(1+i)^t}$$

The present value of the benefit to class A is represented by equation 1 where B_{At} represents the annual dollar benefit to the class, i the discount rate, and T the time horizon. The nature of "i" and of "T" will be discussed below. The present value of a project's variable costs born by class A is represented by:

$$(2) \quad OC_A = \sum_{t=1}^{T} \frac{O_{At}}{(1+i)^t}$$

when O_{At} represents annual operating, maintenance and repair costs. Equation 3, then, represents the total present value cost of a project to class A.

$$(3) \quad TC_A = Z_A + \sum_{t=1}^{T} \frac{O_{At}}{(1+i)^t}$$

The present value of the net benefit accruing to income class A is simply a combination of equations 1 and 3 as represented in equation 4.

$$(4) \quad \text{Net Benefit}_A = \sum_{t=1}^{T} \frac{B_{At}}{(1+i)^t} - \left[Z_A + \sum_{t=1}^{T} \frac{O_{At}}{(1+i)^t} \right]$$

If there is reimbursement for a portion or all of the costs of the project, the analysis is altered, although the basic conceptual framework remains intact. Reimbursement procedures will usually have inherent distribution effects. For example, the Corps of Engineers may allocate a portion of a project's investment cost to its water supply function. Those localities receiving the water supply are required, by statute, to repay over time the allocated cost of water supply. The effect of such a reimbursement procedure upon income group C can be seen in Table 3, and the following mathematical formulation, where:

Z = tax revenue used to finance the water supply function by the federal government.

R = reimbursement in dollars

B = benefits

J = income classes (J = C, D, E).

TABLE 3

EXAMPLE OF REIMBURSEMENT DISTRIBUTION EFFECT

Income Class	Z	B	R
C	10	20	30
D	20	30	20
E	30	20	10

In the example shown in Table 3, income class C pays 10 in taxes to finance the water supply component of the project and through consumption receives 20 benefits. However, federal law requires that the total investment cost of water supply or 60 (assume that all figures are on a present value basis) be repaid to the federal government by the locality receiving the supply.[76] The initial effect on class C is that it pays 10 in taxes and receives a benefit of 20 or a positive net benefit of 10. However, when reimbursement is taken into consideration, the final effect is that class C pays 30 and receives a benefit of 20 or a negative net benefit of 10.[77] For class C the income distribution effect changes from +10 to -10 because of reimbursement.

However, if reimbursement was 100 percent and proportional to the taxes paid, income class C would reimburse 10/60 of R or 10. Proportional reimbursement may be represented as:

$$(5) \quad K_C \left(\sum_{t=1}^{T} \frac{\left(\sum_{J=C}^{E} R_{Jt} \right)}{(1+i)^t} \right)$$

where K_C is the proportion of the total tax paid by income group C. The remainder of the expression is the present value of the total reimbursement, or 60 in the example. The proportion K_C multiplied by the present value of the total reimbursement is the amount of reimbursement that would be paid by income class C if reimbursement was proportional to the tax structure.[78]

The actual present value of the reimbursement paid by income class C may be written as:

$$(6) \quad \sum_{t=1}^{T} \frac{R_{Ct}}{(1+i)^t}$$

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[76] The example and subsequent formulation assumes that annual operating and maintenance costs will either be paid directly by the project beneficiaries or will be non-reimbursable. In any case the analysis would be the same.

[77] The reimbursement figure does not include the original taxes of 10 because it assumed that the 60 in taxes for the project was a loan by society to itself and that loan is being repaid. Therefore, although the federal tax cost to society as a whole is zero, the distribution impact is dependent on the nature of reimbursement.

[78] Note that reimbursement does not need to be 100 percent for this expression to hold.

The difference between the actual reimbursement and proportional reimbursement may be titled the "reimbursement adjustment." It is measured as a positive or negative deviation from the tax structure. The investment cost for an income group, therefore, consists of the initial tax plus the reimbursement adjustment and may be expressed as follows for income group C:

$$(7) \quad Z_C + \left[\sum_{t=1}^{T} \frac{R_{Ct}}{(1+i)^t} - K_C \left(\sum_{t=1}^{T} \frac{\left(\sum_{J=C}^{E} R_{Jt} \right)}{(1+i)^t} \right) \right]$$

The total cost to income group C is expressed by the actual investment cost plus the present value of operating and maintenance costs accruing to income group C. Therefore, the net benefit to any income group, J, is expressed as:

$$(8) \quad \text{Net Benefit}_J = \sum_{t=1}^{T} \frac{B_{Jt}}{(1+i)^t} - \left[Z_J + \left(\sum_{t=1}^{T} \frac{R_{Jt}}{(1+i)^t} - K_J \left(\sum_{t=1}^{T} \frac{\left(\sum_{J=1}^{J} R_{Jt} \right)}{(1+i)^t} \right) \right) + \sum_{t=1}^{T} \frac{O_{Jt}}{(1+i)^t} \right]$$

Conceptual Problems: A number of conceptual problems attend the use of a framework like the one posed above. First, the model presented is intended to measure the initial distribution effects of water resource investments. However, initial distribution effects will cause a successive round of impacts on the economy and, therefore, the final effect will probably differ from the initial impact. For example, assume that income is transferred from group B to group A. The expenditure patterns of group A may be different than those of group B. When group A spends the new increment of income, there will be other distributional effects due to this fact. Similarly, group B contracts expenditures, and this effect is felt throughout the economy. Although these "secondary effects" may be of great importance and can not be passed off as transfers, as similar effects are in the efficiency account, methods of quantification may be difficult to develop and implement. Consequently, they will not be considered in the subsequent analysis. Empirically this may not be of great importance for purposes of this study because the analysis will be confined to a small region where such impacts would be minor. Conceptually and for analysis of larger regions or the nation, however, additional research needs to be done in an effort to explore the implications of the round by round effects.

A similar problem centers in the area of capital gains. Due to resource immobilities, water resource investment will create capital gains to some and losses to others (of a windfall nature), and the distribution of income may be altered in this manner. The distributional model, outlined above, could be adapted to handle such a situation. However, data problems were insurmountable for this test and the issue was not considered.

Third, as indicated above, a discount rate must be selected to discount benefits and costs to a common present value base. Aside from the issues surrounding the estimation of the overall social opportunity cost of capital, it may be desirable to use a different interest rate for different income classes based upon the assumption that income classes will value future benefits and costs differently. Such an adjustment was not considered for this test nor was a discount rate which differed from the current rate used by the federal government explored.

Fourth, the length of the time horizon over which distributional effects are to be considered is another important matter for study. For example, the composition of income classes may change over time due to external factors and, therefore, the demand by any one class for a project's output may be expected to change. Hence, the quantity consumed will be altered, which in turn results in an altered distributional effect. Thus, it would appear that the distributional effects can only be evaluated, using the above formulation without modification, over relatively short periods of time. However, for the quantitative portion of this test the time horizon will be that used for the efficiency analysis--100 years. This implicitly assumes no change over time in the composition of the income classes.

Finally, the actual allocation of project costs and benefits to income classes presented numerous conceptual and empirical problems. These will be discussed as they appear in the analysis to follow.

Implementation of the Model: Given the conceptual model and the simplifying assumptions underlying it, we can now proceed to questions of empirical implementation. This will be done in the context of the Stonewall Jackson Reservoir proposal.

The Region of Analysis: The income distribution effects of water resource investment can vary depending upon the region defined for quantification of such impacts. The model outlined above, however, was formulated from the national point of view. To use it in a regional context, reimbursement would need to be zero or a slight modification of equation 8 would be needed. Such a need stems from the normal reimbursement situation where a local or regional unit of government is required to repay to the federal government all or part of total federal costs rather than just the regional share of federal taxes devoted to a project. Thus, Z_J in equation 8, which in the regional context would denote the regional portion of federal taxes paid by income class J, would give the improper value against which the "reimbursement adjustment" should be applied. The value that should be substituted for Z_J in equation 8 can be represented by:

$$(9) \quad Z_{J\lambda} = \alpha_{J\lambda}(\gamma Z_{JN}) + \phi Z_{JN}$$

where, Z_N represents total federal investment cost; Z_{JN} represents total federal investment cost distributed nationally to income classes in proportion to total federal taxes paid; $\alpha_{J\lambda}$ represents the percent of federal tax revenue paid by income class J and raised in the region; γ represents the percent of nonreimbursable federal tax cost; and ϕ represents the percent of reimbursable federal tax cost. $Z_{J\lambda}$, then, represents the present value investment cost of the project born by the regional component of income class J if that cost is distributed in proportion to the federal tax structure. In other words, Z_λ is the total cost, due to both taxes and reimbursement (but without double counting), of a project to a region. The formula assumes that reimbursement will not exceed federal tax cost on a present value basis.

Because a regional analysis was desired for purposes of this test, the modified form of equation 8 will be used in the following evaluation. The model was implemented for a region surrounding the actual project site and associated downstream locations, defined by zip code areas 263 and 264. The advantage of such a definition is that all flood control and water supply benefits of the project and a majority of the recreation impacts accrue to this region. Moreover, data questions were simplified to some extent by such a choice. Fundamentally, however, in view of the local impact of the reimbursement requirements, the absolute bulk of any distributional impacts will fall in this region. The major change which would take place by analyzing such effects from a national view point would be a required allocation to income classes of both the non-reimbursable tax costs which fall outside the region and a portion of recreation benefits. As indicated earlier, if the budget can be assumed fixed, the impact of taxes on relative distribution will be zero. Thus, the change in relative impact over that obtained from the regional view point would be small and the absolute impact of the project on national income distribution would be infinitesimal due to relative project size.

Initial Income Distribution: Obviously the first step in the analysis is to define the present distribution of personal income in the region. The income base utilized was that of adjusted gross income for the year 1966 as obtained from federal tax returns.[79] The initial income distribution within the region is presented in Table 4. Data limitations permitted only three income classes to be defined.

Benefit and Cost Allocation by Function: In order to determine the net present value of the distributional effects of a project by income classes, it is necessary to allocate a project's benefits and costs to each of its primary functions. For example, the costs and benefits for the flood control function and the distribution effect of this function must be quantified separately from the other functions. This procedure

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[79] Since the analysis was to be carried out using household income as the income base, it was assumed that the tax returns represented household income. However, such an estimate has a downward bias because of the use of separate returns within households. Data to make the necessary adjustments or improved sources of information were not available, however.

TABLE 4

INITIAL INCOME DISTRIBUTION FOR ZIP CODE AREA 263-264

Class	% of Population in Class	% of Adjusted Gross Income in Class
$<3,000	26	11
3,000-10,000	63	62
>10,000	11	27

Source: U. S. Internal Revenue Service, Zip Code Area Data Individual Income Tax Returns, Supplement Statistics of Income, 1966, (Washington: U. S. Government Printing Office, 1969).

is necessary primarily because benefits arising from one function are distributed to income classes differently than the benefits arising from another. Also, cost distributions can change because of reimbursement policy. The net effects of the separate functions are then summed for each income class to determine the total distributional effect of a project.

The magnitude of project benefits and costs for the proposed Stonewall Jackson Reservoir, as originally estimated by the Corps, are given by function in Senate Document 109. The procedure used for allocation of total project costs to individual functions was the "separable cost-remaining benefit" method. Neither this procedure nor any other method used for the distribution of joint costs, however, can be grounded in economic theory.[80] Other methods could be used and would result in different distributions of joint costs to project functions. A different distribution would normally result in the calculation of a different income distribution effect since methods of reimbursement will vary among functions. Thus, the estimation of a project's equity impact is dependent on the method of allocation used for joint costs (when they exist and when non-proportional reimbursement occurs). However, because actual reimbursement requirements are based on the "separable cost-remaining benefit" method and because only reimbursement will alter the allocation of costs to income groups, this conclusion will not affect the analytical results as long as the evaluation is consistent and utilizes the same approach for joint cost allocation. Thus, the separable cost-remaining benefit approach will be used in this test.

In any case, the original allocation of costs to functions as presented in Senate Document 109 was modified because of the change in the discount rate used for evaluation from 3 1/4 percent to 4 7/8 percent

[80] Eckstein, ch. IX.

and to allow for modification of project benefits as discussed under the national economic efficiency account. Since the cost allocation results of the separable cost-remaining benefit procedure vary depending upon the magnitude of benefits arising from each function and because the functional benefits were altered in the reevaluation of the project, the allocation of costs to project function was changed. Appendix 1 shows the calculations for allocation of joint costs based upon the modified benefit and cost estimates. Table 5 presents a summary of the benefits and costs associated with each function of the project.

TABLE 5

BENEFITS AND COSTS BY PROJECT FUNCTION-
STONEWALL JACKSON RESERVOIR

Function	Average Annual Benefit (a)	Investment Cost (b)	Average Annual Operating & Maintenance Cost (c)
Flood Control	$765,000	$29,108,200	$69,300
Water Supply	191,900	1,796,800	-7,600
Recreation	479,000	5,521,000	102,000

Source: (a) Senate Document 109 as modified.
(b) Appendix 1.
(c) Appendix 1. Negative costs arise from the nature of the separable cost-remaining benefit method when used with an economically inefficient project. In essence, one function is subsidizing another.

Average annual benefits and operating and maintenance costs were, then, discounted to present value, as required by the model, using a 4 7/8 percent discount rate and a 100 year time horizon for all functions. The necessary discounting required to implement the reimbursement portion of equation 8 also used a 4 7/8 percent discount rate, but the time horizon was shortened to 50 years in accordance with the appropriate public laws concerning reimbursement.[81] Given the appropriate present values, benefits and costs can be allocated to income classes. This will be undertaken next.

Allocation of Investment Costs to Income Classes: Because the evaluation is being carried out for a region rather than the nation, the investment cost of each function must be allocated to the various income classes in accordance with equation 9. In other words, the actual cost of the project, if it were paid in proportion to the federal tax structure, to income groups within the region is a function of the percentage of federal taxes paid by the groups and the degree of reimbursement required.

[81] Title III, PL. 85-500 ammended by Section 10 of PL. 87-88.

Since the federal tax costs, Z_N, of each function (or more generally of the total project) are raised from general federal revenues, they can be allocated to national income classes on the basis of an allocation of federal taxes to income classes. A recent allocation of the federal tax burden by income classes, published by the Tax Foundation in 1967, was utilized for this purpose.[82] The percentage of federal taxes allocated to the income groups defined for this study is presented in Table 6.

TABLE 6

ALLOCATION OF FEDERAL TAX TO NATIONAL INCOME GROUPS, 1966

Class	Average Federal Tax Per Family (a)	Households in Nation (b)	Total Tax in Nation	% of Federal Tax paid by Income Class
$\leq$3,000	$ 264	11,293,320	$ 2,981,436,480	2%
3,000-10,000	1,317	32,717,160	43,088,499,720	33%
$\geq$10,000	5,637	14,951,310	84,280,534,470	65%

Source: (a) Tax Foundation, Tables B-8 and B-9, 47-48.
(b) U. S. Internal Revenue Service, Zip Code Area Data, 1. Total exemptions in each income class divided by 3.29 people per household. Assumes that household and family definitions are identical. (Note: Average federal tax per family excludes social insurance since it is not part of revenue from which investment funds are drawn.)

Several problems arise from this tax allocation procedure. For example, the income base is defined differently in the Tax Foundation study than in the zip code data. However, the difference is not expected to substantially bias the quantitative results. Another problem is that the average federal tax per family in Table 6 is based on 1960 data while the numbers of households in the nation are based on 1966 data. Therefore, it is assumed that the tax structure was unchanged from 1960 to 1966.

Also, it should be noted that the assumptions of tax incidence used in the Tax Foundation study are crucial to the results. For example, "the most crucial assumption in the tax allocation is that the burden of most business, excise, and sales taxes is shifted forward to the consumers."[83] Many would argue that these taxes are at least par-

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[82] Tax Foundation, Tax Burdens and Benefits of Government Expenditures by Income Class, 1961 and 1965, (New York: Tax Foundation, Inc., 1967).

[83] Tax Foundation, 46.

tially shifted to the factors of production. If different tax incidence assumptions were to be used, different empirical results would be obtained from this study.

The investment cost of each project function assigned to each national income class was determined by multiplying the percentages in Table 6 by total investment cost. This calculation resulted in the distribution of total investment cost (Z_N). However, it is the distribution of regional costs that is desired, so the portion of the total investment cost that is born by the region must be determined. That proportion must be determined by using equation 9.

For flood control, ϕ is equal to zero and, therefore, γ is equal to 100 percent. Thus, if $\alpha_{J\lambda}$ is known the investment cost born by each income class in the region ($Z_{J\lambda}$) can be derived. The $\alpha_{J\lambda}$ values were determined by calculating the amount of total federal income taxes paid by the respective regional income classes as a percent of total federal income taxes paid by the corresponding national classes.[84] The resulting regional costs for flood control are displayed in Table 7.

Although the investment costs for water supply are initially paid from federal revenue, the Federal Water Supply Act stipulates that 100 percent of the total investment cost must be repaid to the federal government with interest at 4 7/8 percent on the unpaid balance over a 50-year period. Therefore, ϕ is equal to 100 percent and $Z_{J\lambda}$ is equal to the investment cost of the function times the percent of federal taxes paid by the appropriate national income class (Table 6). This provides the cost of investment to the regional income classes when reimbursement is proportional to the federal tax structure. The appropriate values are displayed in Table 7.

The Federal Recreation Act stipulated that 50 percent of the separable investment cost of recreation be repaid to the federal government with interest at 4 7/8 percent on the unpaid balance over a 50-year period. Thus, ϕ is equal to 25.6 percent and γ to 74.4 percent based on separable costs of $1,415,000 and total costs of $5,521,000. Using the appropriate Z_{JN} and $\alpha_{J\lambda}$ values gave the results shown in Table 7.

Allocation of Costs and Benefits by Function to Income Classes: Due to the varied allocation procedures used for annual variable costs and for benefits, the methodology utilized will be discussed by function.

Flood Control: Data concerning the distribution of flood control benefits of the project to income classes were nonexistant. However, a personal tour of the project site and flood control area revealed that flood control benefits would most probably accrue to income groups in proportion to the initial income distribution of the region. The flood

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[84] U. S. Internal Revenue Service. The percentages were .07 percent; .07 percent and .03 percent for the under $3,000, $3-10,000, and over $10,000 classes, respectively.

TABLE 7

ALLOCATION OF INVESTMENT COSTS BY FUNCTION AND INCOME CLASS

Class	Function	Investment Cost Born by Nation (Z_{JN})	Investment Cost Born by Region ($Z_{J\lambda}$)
$ <3,000	Flood Control	$ 582,164	$ 408
3,000-10,000		9,605,706	6,724
>10,000		18,920,330	5,676
<3,000	Water Supply	35,936	35,936
3,000-10,000		592,944	592,944
>10,000		1,167,920	1,167,920
<3,000	Recreation	110,420	28,357
3,000-10,000		1,821,930	467,898
>10,000		3,588,650	920,551

Source: Tables 5 and 6.

control benefits forecast from the project are $15,558,598 on a present value basis.

The costs associated with flood control consist of allocated investment costs and allocated operation and maintenance costs. Investment costs were distributed to income groups in the region in Table 7. The present value of annual operation and maintenance costs is $1,409,423 and the appropriate portions were distributed to income groups in the region on the same basis as investment costs. The overall income distribution effect of the flood control function is presented in Table 8.

Water Supply: Water supply benefits were distributed to income classes on the basis of water expenditure by income class as a proxy for the amount of water used by each class. The calculations are shown in Tables 9 and 10.

Investment costs for water supply were distributed to the regional income classes in Table 7. It was assumed that the required 100 percent repayment would be financed by the locality through water charges and that the repayment would be in equal amounts over the entire 50-year period. The annual repayment with interest on the unpaid balance is approximately $97,000 per year. This amount was distributed on the basis of the percent of average water expenditures incurred by each

TABLE 8

DISTRIBUTION OF NET BENEFITS
FROM FLOOD CONTROL BY REGIONAL INCOME CLASSES

Class	Benefits	Investment Cost	Operation & Maintenance	Present Val. Net Benefits
$ <3,000	$4,045,235	$ 408	$ 20	$4,044,807
3,000-10,000	9,801,917	6,724	326	9,794,867
>10,000	1,711,446	5,676	275	1,705,495

TABLE 9

DISTRIBUTION OF WATER SUPPLY EXPENDITURES BY INCOME CLASS

Class	Average Water Expen. Per Household	Households in Region	Tot. Water Expend.	% Water Expenditure
$ <3,000	$ 7.5	9,775	$ 73,313	11
3,000-10,000	17.1	23,484	401,576	62
>10,000	40.0	4,256	170,240	26

Source: U. S. Department of Labor, BLS, Survey of Consumer Expenditure 1960-61, Supplement #3 to BLS Report No. 237-86, Consumer Expenditures and Income, Rural & Farm areas in Southern Region, 1961, (Washington: U. S. Government Printing Office, 1965).

income class. In other words, the actual reimbursement cost was distributed to regional income classes in the same manner in which benefits were distributed.

Operation and maintenance costs are by law paid by the locality, so it was also assumed that these costs would be born by regional income classes according to their water expenditures. The results of the calculations using these assumptions and the distribution of the present value of net benefits is presented in Table 11.

Recreation: Recreation benefits were distributed to income classes on the basis of the percentage of visitors to federal reservoirs by income classes in 1960. The percentages and resulting calculations are given in

TABLE 10

DISTRIBUTION OF WATER SUPPLY BENEFITS BY INCOME CLASS

Class	% of Water Expenditures	Present Value of Water Supply Benefits	Present Value of Benefit to Income Class
$ ≤3,000	11	$3,902,864	$ 429,315
3,000-10,000	62		2,419,776
≥10,000	26		1,014,745

TABLE 11

DISTRIBUTION OF NET BENEFITS FROM WATER SUPPLY BY REGIONAL INCOME CLASS

Class	Gross Benefit	Investment Cost	Reimbursement Adjustment[a]	Operation Cost	Present Value of Net Benefits
$ ≤3,000	$ 429,315	$ 35,936	$+162,507	$-17,003	$ 247,875
3,000-10,000	2,419,776	592,944	+523,642	-95,835	1,399,025
≥10,000	1,014,745	1,167,920	-704,204	-40,189	591,218

[a]Does not add to zero due to rounding.

Table 12. However, Table 12 results in an allocation of total recreation benefits to the region. Obviously only a portion of these benefits accrue to those people who live in the region. For the purpose of this test, it was assumed that 50 percent of the recreation benefits accrue to the people of the region selected for study.[85] Therefore, the relevant benefit value accruing to each class is 50 percent of that reported in Table 12.

Recreation costs involve all three cost components. The distribution of the regional investment costs to income classes was given in

[85]This figure was based upon an estimate made by the Pittsburg District Office of the Army Corps of Engineers.

TABLE 12

DISTRIBUTION OF TOTAL RECREATION BENEFITS BY INCOME CLASS

Class	% of Visitors	Present Value of Recreation Benefit	Benefit to Income Class
$ <3,000	7.5%	$9,741,919	$ 730,644
3,000-10,000	71.8%		6,994,698
>10,000	20.7%		2,016,577

Source: Outdoor Recreation Resources Review Commission, Reports No. 5 and 20, (Washington: United States Government Printing Office).

Table 7. Assuming repayment is in equal installments over the entire time horizon, the annual amount to be repaid is $77,000. The law stipulates that the source of repayment must be limited to entrance and user fees collected at the project. (It is also possible to have repayment in the form of lands, but this possibility is ignored here.) Therefore, the $77,000 is distributed to income classes on the basis of reservoir use by income classes.

Operation and maintenance costs are paid entirely by user fees, so these costs are also allocated on the basis of reservoir use by income class. However, because only 50 percent of total visitation was of a regional origin, only 50 percent of these costs were included in the calculations. The net benefit distribution effect of the recreation function is presented in Table 13.

TABLE 13

DISTRIBUTION OF NET BENEFITS
FROM RECREATION BY REGIONAL INCOME CLASS

Class	Benefit	Investment Cost	Reimbursement Adjustment	Operating Costs	Present Value Net Benefits
$ <3,000	$ 365,322	$ 28,357	$ +78,837	$ 77,793	$ 180,335
3,000-10,000	3,497,349	467,898	+556,147	744,740	1,728,564
>10,000	1,008,288	920,551	-634,974	214,709	508,002

Other Impacts: Although the effects of the so-called expansion or secondary impacts were previously discussed and eliminated from the analysis, two other impacts have not been considered. The first is the possible impact of the project on regional growth and the subsequent distributional effects. For reasons which have been outlined in the section on economic efficiency, this was not considered an important aspect of water resource projects. Moreover, the data requirements necessary to trace the distributional consequences of any such impact would be insurmountable for an evaluation like this one. Therefore, it was not considered in the analysis. Second, the employment impact of the project, which was also discussed in the previous section, obviously has distributional impacts that have not been accounted for. The average annual employment impact was estimated at $137,000 for the entire project. The regional portion of that figure, however, is estimated to be less than 25 percent or $34,250 annually.[86] To this must be added an unknown multiplier component which could range as high as 2.36.[87] This would all be a net gain to the income classes concerned (presumably the lowest income group because of the unemployment although this may not be the case if the unemployment was of short duration or seasonal). An offsetting influence on the region though was the $111,000 annual loss of land productivity estimated in the Corps' report. This would all accrue to the region but its distributional characteristics are unknown. Thus, the two effects were assumed to produce roughly offsetting distributional impacts on the region and were both eliminated from further analysis.

Summary and Conclusions: The total net benefit distribution of the Stonewall Jackson project can now be shown and is presented in Table 14. The project has a positive effect on all income classes in the defined region because the region is not required, through either taxes or reimbursement, to pay even a major share of project costs. This is true even though the project from the national efficiency viewpoint is inefficient. The relative distribution of benefits tends to favor the middle income group with 64 percent of the total but the upper income class receives the largest absolute value per household at $659 of present value impacts. Conversely, the lower income group receives the lowest absolute value per household. Table 15 compares the relative distribution of income in the region before the project with the regional distribution of project benefits. The project would result in a slight distribution effect in favor of the lower income group. The results are of course valid only for the specific region defined and under the assumptions outlined.

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[86] Determined by estimating the percent of total unemployed labor potentially affected by the project that resided in the region. Corps of Engineers, West Fork River..., Appendix X.

[87] Robert R. Nathan Associates Inc., and Resource Planning Associates, Recreation as an Industry in Appalachia, Prepared for the Appalachian Regional Commission (Washington, D. C.: December 1966).

TABLE 14

NET BENEFIT DISTRIBUTION OF
THE STONEWALL JACKSON PROJECT BY REGIONAL INCOME CLASS

Class	Present Value of Net Benefit	% of Net Benefits by Income Class	Net Benefits per Household
$ ≤3,000	$ 4,473,017	22%	$458
3,000-10,000	12,922,456	64%	550
≥10,000	2,804,715	14%	659
Total	20,200,188	100%	

Source: Tables 8, 11, 13 and U. S. Internal Revenue Service. Households in the region number 9,775, 23,484 and 4,256 for the respective income classes

TABLE 15

INCOME DISTRIBUTION EFFECT
OF THE STONEWALL JACKSON PROJECT

Class	Percent of Adjusted Gross Income in Class (a)	Percent Net Benefits in Class (b)
$ ≤3,000	11	22%
3,000-10,000	62	64%
≥10,000	27	14%

(a) Source: Table 4.
(b) Source: Table 14.

THE REGIONAL ACCOUNT

As the Task Force indicates the regional account must be carefully defined before analysis can proceed. The objectives of such an account could embrace "several types of goals ranging from increased total regional income, improved geographic distribution of economic activity,

enhancement of the regional economic base, or improved income distribution within the region itself."[88] Moreover, the objectives can change depending on the scope of the region considering the problem. For example, the nation would likely have a somewhat different view of a proposal for a defined region then the region itself. The Task Force suggests that the regional income objective "will be the most critical." In support of this they also point out that the other aspects mentioned as being important to the regional account will be reflected in the environmental and/or well being accounts.[89]

This implies that use of regional income would receive approval as an indicator of regional progress from a wider set of interest groups and that a regional viewpoint of the situation is implicitly accepted. In other words, the region's view of its own welfare rather than the nation's is the most important criterion and is reflected by total regional income. Some have accepted this as a basis for regional analysis.[90] Others, however, view the situation slightly differently. Perloff points out that measures of regional growth encompass the concepts of both "volume" and "welfare."[91] For example, total sales, income and employment in the region as well as per capita real income, its changes and stability may be important. What needs to be noted is that a linear relationship does not necessarily exist between those measures associated with volume and those related to welfare. Obviously, however, use of per capita measures would provide a relative gauge among alternatives and would, thus, be a better indicator of project ranking for this objective both within a given region and between regions of various physical and economic sizes. The latter is especially important since regional size will influence the absolute size of project benefits and costs. In any case, regional per capita income or employment effects can easily be determined from total impacts and, therefore, the measurement methodology discussed below will concentrate on absolute effects that can be forecast with, as opposed to without, a proposed project. Displays, however, should be structured in terms of the true measure of economic progress - increased per capita income - as well as total regional income.

The analysis of a proposed project for a regional account, defined along the lines of either total or per capita regional income, can

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[88] Water Resources Council, Procedures for Evaluation . . ., 111.

[89] Ibid, 112.

[90] For example, see: John V. Krutilla, "Criteria for Evaluating Regional Development Programs," American Economic Review, XLV (May 1955), pp. 120-132.

Julius Margolis, "Secondary Benefits, External Economics, and the Justification of Public Investment," Review of Economics and Statistics, XXXIX (August 1957), pp. 284-91.

[91] Harvey S. Perloff, How a Region Grows, Area Development in the U. S. Economy, (Supplemental Paper No. 17, published by the Committee for Economic Development, March 1963).

logically be separated into four component parts. First, the net primary national income benefits which accrue to the region(s) must be measured. Such a measurement would include a reduction in national benefits to account for leakages, local taxes and local contributions or other reimbursement. Second, employment benefits resulting from the utilization of unemployed labor should be evaluated. These would be similar to the types of impacts considered under the national economic efficiency account but would include only impacts falling within the region or regions being analyzed. Third, the change in regional growth and its subsequent effect on regional income as a result of a project should be considered. Again, this component is the regional complement of the "use externalities" idea considered under the national economic efficiency account. In fact, the three components of the regional account listed above all correspond to elements of an efficiency analysis. That is why the Task Force suggests that: "It may be useful, as an evaluation technique, to consider, when measuring income gains, the region as the nation (as a closed economy) and apply the basic evaluation principals and techniques set forth in the measurement of the national income benefits."[92] The fourth component of the regional account is, however, dependent on the other three and is normally not included in a national analysis because it is usually only a regional transfer. This impact is the so-called multiplier or expansion results of initial or direct effects such as those occurring under the other components. For example, the positive impacts of recreation development and the negative effects of farm land inundation may be important to regional income. To the extent that these are retained in the region they are a real regional impact even though a pecunary impact from the national viewpoint.

The following discussion will follow the above format. First, however, an issue overriding all of the above must be considered and resolved. That issue is the one of regional definition.

Regional Definition: Regional definition for purposes of project evaluation is primarily a value judgement that must be made by the analyst. However, the result of that judgement has important implications. For example, the magnitude of regional income benefits can be very sensitive to the economic size of the region. Thus, as has been pointed out elsewhere, the "size of a region can be arbitrarily varied so as to adversely affect the computation of regional benefits from viable alternatives which differ in nature or location from a given course of action."[93] Moreover, projects can be constructed outside the region they are supposed to benefit. As an example, the Corps of Engineers have proposed a series of structures for the Potomac River headwaters as a means of alleviating pollution downstream near Washington, D. C. What region or regions are appropriate for regional analysis in such a situation?

The latter case brings into shape focus the problem of interregional transfers. As Castle has pointed out:

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[92] Water Resources Council, Procedures for Evaluation..., 113.

[93] Kalter, et. al., Criteria for Federal Evaluation..., 9.

> A system of regional accounts might be established that would make explicit the regional transfers of income that accompany the development of such projects. If it is relevant to know how much a region benefits from a project, it is also relevant to know which regions, if any, have sacrificed potential benefits to make this possible.[94]

Thus, the regional account should show, for example, not only the impacts of the western reclaimation project on the region containing the project but on the Mississippi delta county where returns to cotton production could be adversely affected. Pointing this out, however, does not take us very far in our quest for a means to define the region or "system" of regions to be used in an analysis. Nor does it leave us overly comfortable with the Task Force suggestion that the OBERS regions be used for this purpose since their correspondence to a judgement about the significant area(s) needed in the evaluation may be weak or they may be incompatible with other data sources.

As Meyer has commented:

> Traditionally three different approaches have been used in defining regions. The first stresses homogeneity with respect to some one or combination of physical, economic, social or other characteristics; the second emphasizes so-called nodality or polarization, usually around some central urban place; and the third is programming- or policy-oriented, concerned mainly with administrative coherence or identity between the area being studied and available political institutions for effectuating policy decisions. . . . regional definitions as established in practice often represent a compromise between these different pure types. In particular, availability and limitations of data can and do dictate departures. . .
>
> Strictly speaking, however, the three traditional definitions of regional type are not mutually exclusive. . . . all regional classification schemes are simply variations of the homogeneity criterion . . .[95]

Thus, we are left with the need to make the value judgement. Perhaps the best guideline to use in this process is to specify that areas impacted differentially by a project should be isolated as separate regions. For the Stonewall Jackson project, this implies a "close in" impact area (an area where the majority of the primary benefits will accrue) plus a somewhat broader or intermediate sized region to cover the area primarily concerned with recreation opportunities at the reservoir. The intermediate region could coincide with the State of West Virginia because of the reimbursement requirements for recreation components of

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[94] Emery N. Castle, Testimony presented to the Water Resources Council Hearings, in Portland, Oregon, August 11, 1969, mimeo.

[95] John R. Meyer, "Regional Economics: A Survey," American Economic Review, LIII, No. 1 (March 1963), p. 22.

federal projects or it could cover parts of a multi-state area where the potential reservoir users reside. This region would differ from the "impact area" in that it would receive an additional portion of the primary recreation benefits and bear an increased part of project costs. The other categories of impacts, mentioned above, would appear to be relatively minor. Finally a third region for a systems of regional accounts could be identified which would include the remaining parts of the nation. The analysis of such a region would be characterized by the absence of any substantial beneficial impacts of the proposal and the requirement of bearing major portions of the forecast costs.

For purposes of evaluation, the "impact" region for the Stonewall Jackson project was chosen and defined to include the region covered by the 263-264 zip code area. This area surrounds the project site and includes all the land and communities affected by the water supply and flood control components. The definition is also consistent with that used for the evaluation of the well-being account. In addition to an evaluation for the impact area, a summary will be made of the project impacts on an intermediate region defined as the remaining portions of the State of West Virginia. No quantification of the project cost to the rest of the nation will be undertaken.

Regional "Primary" Impacts: It goes without saying that net national income benefits resulting from the primary outputs of a project are also real gains to a defined region to the extent that their incidence (as opposed to initial impact) falls within that area. Thus, the problem becomes the empirical one of separating efficiency benefits and costs by region and calculating the net regional impact. However, issues of reimbursement complicate the analysis in the same way as for the personal income distribution model. Because of this, the model previously outlined and used for that account can also be used, with a slight modification, to determine regional impacts of primary outputs. The modification required is one which permits benefits and costs to be aggregated across income classes to obtain the overall regional effect. Since the region being analyzed for this test is the same for both accounts, the empirical results given in the previous section can also be utilized here. Table 16 displays these results and the aggregated totals for the region. It was assumed that the regional impact of project effects also denoted regional incidence or that impacts were not shifted between regions.

Regional Employment Impacts: As indicated previously, the benefits stemming from the project's use of unemployed labor were forecast to be $137,000 annually.[96] However, the regional impact was estimated at only $34,250[97] annually or $696,578 on a present value basis. This figure was added to the regional benefit values.

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[96] See pages 24 to 27, above.

[97] See footnote 86.

TABLE 16

PRESENT VALUE REGIONAL IMPACTS
FROM PRIMARY FUNCTIONS - STONEWALL JACKSON RESERVOIR

Function	Present Value Gross Benefits	Present Value Costs[a]	Present Value Net Benefits
Flood Control[b]	$15,558,598	$ 13,429	$15,545,169
Water Supply[c]	3,863,836	1,625,718	2,238,118
Recreation[d]	4,870,959	2,454,058	2,416,901
Total	24,293,393	4,093,205	20,200,188

[a]Includes investment costs and operation, maintenance and repair costs.

[b]Source: Table 8.

[c]Source: Table 11.

[d]Source: Table 13.

Regional Growth Impacts: The effects of water projects on national growth (through productivity change) were discussed conceptually in a previous section.[98] It was concluded that "only if a strong a priori case can be made that shortages of water services act as a constraint on more optimal production or that a water project will bring about technological change" should an analysis of the needed demand and cost functions be undertaken. Since these factors were not present in the Stonewall Jackson project further analysis to quantify such national growth impacts was not carried out. Absence of growth impacts at the national level implies a similar situation at the regional level. Thus, no further analysis was attempted on this aspect of the regional account and net benefits from it were assumed to be zero. However, an annual land productivity loss of $111,000 was forecast by the Corps study report. This would all accrue to the region and, therefore, the $2,257,524 of present value impact was included as a negative benefit for the regional evaluation. Note, also, that the type of economic growth considered here was that which would come about because of changes in technology and the resulting change in productivity. If increased regional income is the goal, it can come about in another way. This will be considered next.

[98]See pages 23 to 24, above.

Regional Multiplier Impacts: The multiplier or expansion impacts of direct (initial) project effects can be important regional gains or losses although they are normally considered a transfer payment from the national point of view.[99] Formerly described as "secondary benefits," these impacts refer to the round by round respending effects of alternative courses of public action.

However, their quantification, through such techniques as interindustry analysis,[100] can lead to the measurement of artificial growth impacts. This stems from our definition of regional growth and the assumption made concerning regional employment. If full employment is projected for the region over the project's time horizon, multiplier effects can merely result in a labor inflow to the region with no necessary improvement in regional per capita incomes. On the other hand, if full employment is not forecast or if slack (underemployment) exists in the regional labor markets, multiplier impacts can cause a real change in regional per capita incomes. Also, a redistribution of labor resources toward higher valued occupations because of the project could result in improvement in the average per capita income regardless of the rate of unemployment.

Thus, if per capita rather than total regional income is important, the assumptions the analyst makes on these issues is critical to the evaluation results. Moreover, most empirical situations would tend to present a mixture of conditions rather than one of the polar cases outlined above. Little research exists to resolve this problem. From observation, the impact area of the Stonewall Jackson project would appear to be one of some labor underemployment, especially in specific

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[99] Only when less than full employment conditions prevail are such effects considered a real national gain. Employment impacts have been previously considered, however.

[100] For further discussion of the use of interindustry models as a means of quantifying the secular growth in regional income due to public investment, see:

Robert J. Kalter and William B. Lord, "Measurement of the Impact of Recreation Investments on a Local Economy," Am. Jour. of Agr. Econ., Vol. 50, No. 2 (May, 1968), pp. 243-256.

Robert J. Kalter, An Interindustry Analysis of the Central New York Region, Bulletin 1025 (Ithaca, N. Y.: Cornell University Agricultural Experiment Station, May 1969).

Brian J. L. Berry, Strategies, Models, and Economic Theories of Development in Rural Regions, Agricultural Economic Report No. 127, Economic Research Service, U.S.D.A., Dec. 1967.

Werner Z. Hirsch, "Input-Output Techniques for Urban Government Decisions," Amer. Econ. Rev., Vol. 58, No. 2 (May 1968), pp. 162-170.

E. M. Lofting, The Leontief Input-Output System and Its Application to Analysis and Projection for Water Resources Planning, Water Resources Proj., Dept. of Civil Engin., Univ. Calif., Berkeley, Mimeo.

economic sectors. Given the obvious value judgements required, however, a sensitivity analysis of this type of impact would appear beneficial.

In any case, the distributional impacts of the project within the region from the standpoint of economic sectors (as opposed to personal income groups) may be of importance for political and cost sharing reasons. The most empirically workable model to estimate both distributional consequences and changes in total regional income is that of interindustry analysis.[101] However, as Berry has pointed out:

> The problems of this kind of analysis are many. Some are similar to those of economic base analysis. Data on interindustry flows are scarce. Linear homogenous relationships do not necessarily obtain, and technical coefficients may well be unstable through time. Production functions may be irregular and stepped or "lumpy" rather than continuous over time. On the other hand, the input-output method of analysis is more general than the economic base method. It spells out specific multipliers for each industry. Hence, when used in the correct context, it may provide findings of considerable value.[102]

These conceptual issues, along with the fact that the model is usually applied by forecasting exogenously the changes in final demand resulting from a proposed governmental investment, raise a number of empirical problems to the use of the method. Some of these will be examined in more detail below. Yet, if our basic objective is to develop a procedure to determine the direct, indirect and induced economic effects of government investment, this appears to be the best method currently available. As Kalter and Lord have stated:

> When used in conjunction with other studies, [interindustry] models provide a practical tool which can be used to estimate the magnitude and distribution of such economic effects. Given an independent estimate of the initial (direct) impact of a proposed investment, we can derive estimates of net regional benefits (regional benefits minus regional costs) from the income transactions matrix of the . . . model and the associated inverse matrix and income multiplier values. More specifically, given adequate supporting data, we can estimate the regional benefits accruing during the year of model formulation as well as make projections of future benefits.[103]

Other than the conceptual problems of the model,[104] several em-

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[101] Meyer.

[102] Berry, 26.

[103] Kalter and Lord, 253.

[104] These issues are adequately discussed elsewhere. For example, see: Hollis B. Chenery and Paul G. Clark, Interindustry Economics (New York: John Wiley and Sons, Inc., 1959).

pirical problems attend its use for purposes of regional evaluation of proposed investments. First, the model is highly restrictive in terms of data requirements and can, thus, be both time consuming and expensive to implement for regional areas. Use of national models is far from satisfactory because of the need to ignore the trade relationships for the region. No satisfactory answer to this problem is available. A rough approximation of regional multipliers can be obtained for a region by comparing it to a similar region(s) in economic size for which models have previously been derived. However, this is usually not a satisfactory method of determining impacts on the various economic sectors because of regional differences.

Second, use of the multiplier values forthcoming from the model is dependent on independently derived estimates of the magnitude of the direct (initial) effect of a proposed program. These estimates differ from the forecasts of primary project benefits since an actual increase in spending within the region, of non-regional funds, as a result of the project is needed to obtain any net regional increase. Anything else would merely be an intra-regional transfer.[105] Thus, project caused changes in regional production for export (including the "export" of recreation services to non-residents) and the increased expenditure of non-regional funds on the project itself (construction and operation) need to be quantified before the multiplier values can be utilized. Of course similar impacts of a negative nature should also be analyzed. For example, how many businesses will the project eliminate and what will be the initial impacts of such a reduction.

Finally, care must be taken to estimate only the net impacts of final demand changes to the region. The regional gain or loss is not the total value of the change in sales as a result of project construction but only the change in regional income.

For the impact area of the proposed Stonewall Jackson reservoir, the major monetary effect, resulting from the project, on businesses in the region would be caused by the recreation component.[106] An average annual visitation rate of 375,600 was forecast with 50 percent

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[105] However, if a project halts an outflow of funds due to non-availability of facilities, a net regional gain could result. For example, the provision of regional recreation facilities which would retain the tourist dollar of residents within the region can be a regional gain resulting from the project if it can be proved that the outflow would have continued without the project.

[106] As already noted, the flood control and water supply components do not appear to be important factors in the production functions of regional industries. Moreover, it can be assumed that, aside from the employment impact, most of the income generated by project construction will accrue outside of the area because of the inherent leakages in this type of activity.

or 187,800 visitor days having their origin outside the region.[107] Assuming that the average transfer cost (out of the pocket costs for such items as gas, meals, lodging etc.) of a visitor day at a federal reservoir amount to $5.00[108] and that $2.50 of that expenditure is spent in the impact region, the annual increase in regional sales amounts to $469,500. However, if only 10 percent of sales are retained in the region as increased income or value added, the net regional gain drops to $46,900 annually. To this can be applied an income multiplier value for the appropriate change in final demand. No interindustry analysis exists for the region but other studies on small regions have derived multiplier values from around 1.50 to 2.00.[109] Taking the employment multiplier for the region derived by Nathan and Associates of 2.36[110] and using it as a proxy for value added gives a total annual change in regional income of $110,684. However, due to the seasonal nature of the recreation industry and, its low wage structure,[111] and because underemployment can not be assumed to exist in all the relevant economic sectors, only a portion of this total can be assumed to be retained within the region and added to per capita income. For purposes of this evaluation, this amount was estimated at $55,000. From this must be subtracted any negative impacts of the project on the region. No estimate of such an impact was available nor can great confidence be placed on the leakage estimates. Thus, the sensitivity of the total regional impact to a 20 percent change in multiplier impacts was tested.

Summary: Table 17 summarizes the regional impact of the Stonewall Jackson proposal. Using the assumptions and methods discussed above, a net gain of $19,757,836 to the "impact area" was forecast.[112] The net gain excluding the multiplier impact was forecast at $18,639,242. Given the current population of the region and under the assumption that

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[107] It was assumed that the region has sufficient alternative facilities to retain the 187,800 local visitor days within the region without the project.

[108] See: Kalter and Gosse, Appendix M.

[109] See: Kalter, An Interindustry Analysis of the Central New York Region.

Hays B. Gamble and David L. Raphael, A Microregional Analysis of Clinton County, Pennsylvania (University Park: Penn. State Univ., 1965).

[110] See footnote 87.

[111] Robert R. Nathan Associates, Inc.

[112] A 20 percent adjustment in the multiplier impact would result in an approximate change (gain or loss) of $224,000 in the net impact. Thus, the evaluation results do not appear sensitive to reasonable errors in forecasting this component nor in the assumption regarding the extent of regional underemployment.

TABLE 17

PRESENT VALUE REGIONAL IMPACTS
OF THE PROPOSED STONEWALL JACKSON RESERVOIR

Impact	Benefits	Costs	Net Benefits
Primary	$24,293,393	$4,093,205	$20,200,188
Employment	696,578		696,578
Growth	-2,257,524		-2,257,524
Subtotal	22,732,447	4,093,205	18,639,242
Multiplier[a]	1,118,594		1,118,594
Total	23,851,041	4,093,205	19,757,836

[a]Only net income impact, based upon $55,000 annual increase, is given.

it would remain constant over the project life, this averages out to approximately $527 and $497 per household, respectively. Both figures, however, are on a present value basis and the actual benefits would accrue to the region over a 100 year period. The benefit-cost ratio to the region of the project, exclusing the multiplier impact, is 5.6.

Using similar methods to estimate the project impact on the State of West Virginia, exclusive of the 263-264 zip code area, resulted in the following present value benefit estimates

Primary Recreation Impact	$ 4,481,283
Employment Impact	2,092,734
Growth Impact	0
Subtotal	6,574,017
Est. Income Multiplier	1,000,000
	7,574,017

The State share of federal costs totals $2,446,917 on a present value basis. Thus, a net benefit of $5,127,100 or $4,127,100, depending on whether the multiplier impact is included, accrues to the State outside of the impact area. Because interindustry models for the specified regions were not available, no attempt was made at showing the distribution of net benefits among the economic sectors for either region.

THE ENVIRONMENTAL QUALITY ACCOUNT

A review of the history of water development in the United States demonstrates a consistent concern for general economic growth. To facilitate this growth, the economy needed transportation. This need was reflected in federal expenditures to develop waterways for navigation purposes. At the same time, irrigation, which was essential for the development of the western states, lead to public expenditures for water storage reservoirs. Similar situations developed around the other water functions.

During this period of growth and development, there was only local concern for environmental quality and that centered on health problems. Water had been linked to diseases like cholera and typhoid. On the federal level, the effects of low water quality were considered as insignificant relative to the growth that was occurring. However, communities faced with these water-related health problems recognized the necessity of water quality control, although the effects on health induced by low water quality were not reflected in the market place. As a result, water quality control became a locally financed public service which lead to investment in control facilities.

However, early in the 20th century, the consequences of rapid economic growth became more apparent. The local water supply facilities were, at times, not sufficient to maintain water quality. Apart from society's loss due to health problems, it was recognized that a major cost of growth was the loss of many areas of scenic beauty and uniqueness. At the same time, the concern for national growth and development had taken an efficiency point of view. Individuals like Gifford Pinchot were concerned with using all natural resources so as to assure maximum sustainable yield. Although this concept lead to a reduction in wasted resources, the consequences of rapid growth were still not adequately considered in planning. In reality, the induced water quality reduction was affecting more than the individual localities. However, by the end of World War I, the U. S. Congress had begun to realize that there were costs to growth and development as well as conflicts between the many functions of water. During the 1920's, Congress authorized the Corps of Engineers to survey all of the major river basins to ascertain the general needs of the people. From these surveys, a multiple objective plan could be developed which would facilitate the provision of the needed quantity of good quality water.

Participating in this general trend was the "Conservation Movement."[113]

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[113]The "Conservation Movement" is a generic term to describe informal coalitions of individuals and groups concerned with the conservation of natural resources. The initial concern was with preservation of resources. The leader at this time was John Muir. Early in the 20th century, the physical waste of natural resources was attacked as morally wrong by leaders like the efficiency minded Gifford Pinchot and W. J. McGee, in conjunction with the American Forestry Association. During

Before 1900, the "Movement," which had gained public support on the basis of preservation concepts, had little political influence in the development minded Congress. However, early in the 1900's it shifted to a policy of wisest use as measured by a technical efficiency concept. Efficiency was accepted by Congress and became a key concept in water resource development. With the advent of multiple-objective planning, technical efficiency gave way to economic efficiency as the major criterion for evaluating water development projects.

During the 1930's, Congress formalized the concept of economic efficiency by requiring that the benefits to whomever they may accrue must exceed the costs of a project. Since that time, the theory behind benefit-cost analysis has been expanded to facilitate consideration of externalities caused or corrected by public water investments. However, the empirical problems in measurement have made effective consideration of externalities almost nil.

While the empirical problems are still present today, they need to be solved since externalities must be considered effectively in the future. Evidence of environmental deterioration is present to justify the claims of today's "Conservation Movement". These claims, which have often been manifested in emotional appeals, have forced the consideration of environmental quality as a real national objective along with growth and development.

Aware of the implications of environmental deterioration, the Special Task Force on Evaluation Procedures of the Water Resources Council has taken a step forward through the incorporation of the environment quality objective into their proposed multi-objective evaluation procedures for water development projects.

The Relationship of Environmental Quality to Evaluation: With respect to natural resources, terms like prevention, preservation and protection have been associated with the "Conservation Movement" throughout its history. These terms are emphasized when the Task Force Report cites the types on environmental quality effects to be considered in planning water development projects. The four types of effects cited are: (1) The preservation or enhancement of aesthetic areas; (2) the protection of areas of archaeological, historical, or scientific value; (3) the protection or enhancement of water quality; and (4) the prevention of erosion and the restoration of eroded areas with particular emphasis on the treatments of watersheds, mined areas, and critical erosion areas.[114] In effect, the environmental quality account is to facilitate the specific expression of the "Conservation" consequences of a water development project.

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the 1930's, the prevention of soil erosion and proper management of fish and wildlife were the major concern of the "Movement." The leader through this phase was the energetic and evangelistic Hugh Bennett. At the present time, the concern is with the problems of pollution and protection of scenic beauty.

[114] Water Resources Council, Procedures for Evaluation..., 23.

For any project, the environmental quality consequences can be expressed through three basic mechanisms. The most general approach is one in which all the impacts of a proposed change are considered with respect to all the objectives of society. Conceptually, then, the goals of society are expressed as components of a social welfare function and the impacts of any change with respect to these goals are weighted by the preferences of society. The concept abstracts from a measure of monetary value by assuming a measure of utility such as utils. By this means the social welfare gained from public goods can be expressed since the nature of such goods does not enable the market economy to allocate scarce resources so as to maximize social welfare.

The Task Force specifies the objectives of society to be four in number with environmental quality being included. The problem is in defining the weights attached to the various goals and in measuring the consequences of proposed investments to these goals. Considerations of measurement for environmental quality will be discussed later in this section but a discussion of social welfare weights will not be undertaken here. This topic is reserved to the final section.

Because of problems associated with the measurement of quality differences with respect to the environment, the analyst of governmental investment has been restricted, at best, to placing monetary values on this type of impact. An environmental quality change is often classified as a technological externality and measured in either physical or value terms. Once so classified and quantified, the impact can logically be included as part of a benefit-cost analysis for the national economic efficiency account. Since a water development project may produce, as well as correct, adverse or beneficial effects on the environment, which in turn influence the consumption or production pattern of others due to physical linkages, the value of the externalities is a relevant consideration. However, not all such impacts can be measured nor does such a definition delimit the meaning of environmental quality. Thus, an economic efficiency analysis cannot fully express the environmental quality effects. Because of this, a separate environmental account is justified in which the effects are specified in physical, rather than value, terms.

In such an account the consequences of public investment on environmental quality would be displayed in physical terms but labeled as either beneficial or detrimental. No attempt should be made to present the consequences in terms of common values since, by definition, this is not possible. The political decision maker, then, is forced to apply a more general concept of social welfare. By accepting this method, the economic analyst is forced to admit that current measurement techniques are insufficient to express quantitatively all the environmental consequences. To the extent that such measurement is possible, the derived information should be included in the evaluation display. However, the value measures should not be weighted more heavily than physical measures when decisions are made.

In the next section, the measurement of the different types of environmental consequences will be explored. This examination will show

the practical difficulties in evaluating environmental quality through such mechanisms as welfare functions or economic efficiency analysis However, this is not to imply that quantification for such models is an unjustifiable concern of the economic analyst, but rather that much additional research must occur before these concepts can be incorporated into the political decision process as it affects environmental quality.

Measurement of Environmental Quality: Regardless of the method of viewing environmental quality, exact physical measurements are required particularly for effects which are not readily observable. However, the state of knowledge with respect to the measurement of these effects is limited. Above the physical measurements, the valuation of the effects for partial equilibrium analyses presents additional problems. Considering each type of environmental effect separately, relevant factors with respect to measurement will be discussed.

The Preservation or Enhancement of Aesthetic Areas: Due to the psychological nature of aesthetic pleasure, the measurement of the effect of quality differences on the level of consumption is difficult. One individual's enjoyment of nature may depend on the observation of plants and animals, while another may enjoy hiking because of his view of the mountains. With respect to the social welfare function, these differences could be measured because the individuals would gain a different level of utils from the experience depending on its nature. In evaluating a project, the utility measure would provide a quantitative expression of the aesthetic value of the area. The concepts of vicarious consumption and option demand could be measured from the utility functions. For any project, this type of effect would be calculated as the net change in welfare. However, the most common quantitative measure of utility is willingness to pay because of the inability to quantify psychological relationships. When the analyst accepts willingness to pay as the measure, the value of aesthetic quality is assumed to be reflected in the price. However, willingness to pay measures could be obtained for both option and vicarious demand. The sum of the willingness to pay for physical, option, and vicarious enjoyment of an area is the measure of the benefits for a partial equilibrium analysis. For cost quantification, the social resources are also valued in terms of utils and the cost of the project in a social welfare function is the sum of values of various component resources. Similarly, the costs in the partial equilibrium analysis are the dollar prices of the component resources from the market system.

The real difference between the social welfare concept and the benefit-cost concept is the failure of the latter to fully consider the effect of quality on the level of utility. From the viewpoint of social welfare, the satisfaction from a recreation area may decrease even if more activities were provided. Consumption patterns may be changed so that society would gain a lower total utility from developed recreation than from wild recreation. The necessity of this type of consideration arises because the market allocation system does not reflect aesthetic quality. Therefore, benefit-cost analysis cannot provide answers which go beyond the assumptions underlying the analysis.

As an alternative, a display approach could be utilized. This approach assumes the observations of a naturalist would be more relevant than those of a technically trained analyst. The naturalist who is spurred by philosophical values could prepare the display which would be a statement of the aesthetic qualities that would be destroyed if the project were constructed as well as those qualities which would be enhanced by construction. An example is a reservoir project in which a picturesque hiking trail is inundated, but small islands suitable to primitive camping are developed. The tradeoff in this case must be made according to the personal preference of the decision-maker, however, the display will provide him with a more complete listing of these consequences. The consequences that are significant in the area of the West Fork River will be presented later in this section.

Protection of Areas of Archaelogical, Historical, or Scientific Value: The philosophical quality of life for any person, society, or mankind in general is dependent on those features of the past that depict the movement of life. Therefore the destruction of archaelogical and historical areas which have been key steps in this movement should be considered in evaluating a water development project. Furthermore, the maintenance of areas of scientific importance must be evaluated A dollar measurement of the cost of utilizing an alternative area could serve as one measure of primary benefits. However, if the area is a unique natural laboratory, its protection should be valued highly and may not be capable of monetary quantification.[115] However, if the area is not unique in this regard, the value of its protection will be decreased.

For aesthetic quality, the protection of unique areas could be reflected in the utils of a social welfare function. Benefit-cost analysis, however, does not reflect the entire social willingness to pay. Without a total measure of willingness to pay, the value of protecting these areas is unknown. The alternative is again to display the consequences in physical terms and leave the tradeoff decision to the political world. An adequate display of these consequences requires evaluation by trained historians and/or scientists. These experts would conceptually apply the criteria of authenticity, uniqueness, and essentiality as they examine the consequences of the project.

The Protection or Improvement of Water Quality: In the social welfare model, these considerations are reflected in the value of social inputs and outputs. However, in the efficiency model, these relationships are technological externalities. They represent differences between private costs and social costs and are not reflected in market prices. If a public action either produces or corrects the misallocation, the positive or negative benefits can conceptually be included in the efficiency account. However, not all of the externalities are measurable in value terms. Therefore, the environmental account should also display these consequences in physical terms. In other words, the valuation methods are such that physical consideration is justified.

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[115] John V. Krutilla, "Conservation Reconsidered," American Economic Review, Vol. LVII (Sept. 1967) pp. 777-86.

The Prevention of Erosion and the Restoration of Eroded Areas: This type of environmental quality effect differs from the previous type in that the producer of the externality cannot be easily specified. The pattern of land use determines the influence of erosion on water quality. Therefore, all land users affect the quality of the water, but measurement of the individual user's effect is virtually impossible. If a water development project improves the ability of a group of individuals in a watershed to prevent erosion, the quality of the total water body is improved. The increased water quality is reflected in the efficiency account as increased value of other uses or as reduced cost of performing water quality maintenance activities. In mined areas, the problems of acid as well as erosion can be influenced by a water development project. In this case, the effect is also measured in economic terms as the increased value of production in the industries that benefit from the improved water quality. On the other hand, a water project may produce conditions which destroy an operative watershed area, thus making the water quality worse and reducing the level of activity in the other uses. Finally, if the project reduces the need for conservation activities, the amount of the decrease in these expenditures is a benefit of the proposed project. Alternatively, the project might require increased conservation expenditures which would represent a negative benefit.

These effects, then, can be considered in an efficiency analysis. However, the measurement problem is such that a physical display provides the political decision-maker with additional information for evaluation.

Analysis of the Environmental Quality Account - Stonewall Jackson Reservoir Project: Based on the discussion above, the various types of environmental effects from the proposed project will be presented as a display of beneficial and detrimental consequences. The display will be in physical terms. Previous sections have applied value measures to quality components when it was feasible. Because of the physical nature of the display, no discussion of the appropriate time horizon or discount rate will be undertaken.

The Preservation or Enhancement of Aesthetic Areas: The dam on the West Fork River at Brownsville, West Virginia, would destroy the picturesque wooded and grass hillsides of the area. However, these hillsides are not unique to the region. At the same time, the resulting reservoir could produce islands which have a primitive quality for camping. Such a development would probably provide greater total satisfaction than is presently being obtained. However, the knowledgeable observations of an experienced naturalist rather than this test team should confirm the above conclusion.

For this project, aesthetic quality is influenced by the type of outdoor recreation activity available. For instance, the project will inundate 35.1 miles of low quality stream fishery and produce a reservoir fishery of possibly medium quality. Therefore, the stream fisherman loses utility, while the reservoir fisherman gains. In general, one

would conclude that an increase in total utility due to improvement in fishery quality would take place.

Protection of Areas of Archaelogical, Historical, or Scientific Value: The opinion of the National Park Service was that the area had no archaelogical or historical character. However, a private research study designated six areas in the basin that might be important in this regard. Studies of this type could provide the decision-maker with further insights about the area.

With respect to historical value, construction of the dam will inundate some established family farm operations which may have historical significance. An example is the Jewels' family farm which has been located in the West Fork valley since 1883.

From the scientific standpoint, the reservoir could serve as a laboratory for studying the ecological process of eutrophication. The wildlife mitigation area could serve researchers in studies of succession and adaptation. Since this area as well as the lake are not unique, their benefits for scientific purposes are not assumed to be great.

The Protection or Improvement of Water Quality: Referring to the previous discussion, the effect of water quality on production and consumption activities can be viewed as a technological externality. Therefore, the degree to which resource reallocation occurs because of a water development is a justified increment of the efficiency account. However, the effect in physical terms may provide a better description of the quality impact because of our inability to measure in value terms all the relevant considerations. Because of this, the physical effects should be displayed in the environmental quality account. The section on water quality benefits from the Crops study report provides the physical information that will be utilized in this analysis.[116] Due to the elaborate nature of the determinations, this information will not be recalculated. However, when these procedures are applied to other projects, the input of a biological scientist (aquatic biologist or limnologist) would increase the reliability of such determinations.

Looking specifically at the effects of the proposed reservoir, the following water quality effects were considered: (1) Reduction in hardness; (2) Acid Reduction; (3) Reduced acid corrosion; (4) Water temperature control; and (5) Increased assimilative capacity. Although such effects are interrelated, they will be considered separately for purposes of clarity. Provision of increased assimilation capacity is not discussed because of its relative unimportance as a project effect.

Hardness in water causes excessive scale formulation in industrial and municipal equipment. The industrial costs incurred arise from heat loss, scale removal operations, periodic draining of cooling systems, reduced production and water supply contamination.

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[116] Corps of Engineers, West Fork River..., Appendix V.

The hardness concentration of the river system was determined to be 150 mg/l. The hardness concentration of the water released from the reservoir was forecast at 60 mg/l. Based on a flow of 100 cfs, the hardness concentration will be reduced by 5.3 mg/l for an average of 151 days per year on the Monongahela River and 69 mg/l for an average of 241 days on the West Fork River. In the efficiency account, the savings in treatment costs (labor or chemicals) was used as the measure of benefits. Using this measure, the approximate 2010 annual benefit for hardness reduction would be $33,000 in the West Fork and $6000 in the Monongahela River.

The adverse effects of acid mine drainage from active mines can be alleviated by flow regulation. The report forecasts the average annual total acidity concentration to be about 10 mg/l in the reservoir. If the reservoir maintains a flow of 150 cfs, the average acidity concentration in the Monongahela and West Fork Rivers would be decreased 2.7 mg/l over a period of 168 days and 7 mg/l over a period of 277 days, respectively. Again, if benefits are measured as treatment cost reduction, the approximate 2010 annual benefit in the Monongahela River would be $10,800.

Furthermore, the acid corrodes equipment of those industries utilizing the river for transportation and navigation. The annual benefits to docks, dams, boats, and barges in the Monongahela River resulting from reduced corrosiveness are estimated to be $6,000 from a 100 cfs minimum continuous discharge. This is based on a Corps of Engineers report which estimated acid corrosion damage on the Monongahela River to be $877,000 annually.

Cooling water for steel production and thermal electric power generation results in increased river water temperatures. Flow regulation by the reservoir will reduce the effect of waste heat by maintaining greater flow volumes in the Monongahela River. Based on the analysis of a thermal-electric power plant on the Monongahela River, the annual benefits from stream flow regulation for cooling water were estimated to be $11,000.

The Prevention of Erosion and the Restoration of Eroded Areas: Since there are no mines in the immediate area of the reservoir, only the effects on watershed and critical erosion areas will be discussed. The steep hillsides of the West Fork river valley, which are critical erosion areas, are not farmed. Therefore, erosion effects would appear to be minor. However, watershed activities are occuring on two tributaries of the West Fork (Tenmile Creek and Polk Creek). The effect of the Stonewall Jackson Reservoir on the benefits and costs for these projects is unknown. However, the SCS projects include flood control components with benefits accruing to the West Fork basin. Therefore, a undetermined amount of flood control benefits could be double counted. The presence of this possible double counting should be specified in the evaluation.

Summary: Table 18 presents the environmental quality display for the Stonewall Jackson Reservoir Project.

TABLE 18

ENVIRONMENTAL QUALITY DISPLAY - STONEWALL JACKSON RESERVOIR

	Beneficial Consequences		Detrimental Consequences
A.	1. Primitive camping on the small islands produced by the dam.	A.	1. Inundation of the picturesque wooded and grassland hillsides which are not unique in the region.
	2. Possible establishment of a medium quality reservoir fishery.		2. Inundation of a low quality stream fishery - 35.1 miles.
	3. The improvement in the scenery for recreation related commercial enterprises.		
B.	1. The Reservoir and the wildlife mitigation area could serve as a natural ecological laboratory. However, these areas are not scientifically unique.	B.	1. Inundation of old farms with possible historic value.
C.	1. Reduction in hardness concentration of 5.3 mg/l for an average of 151 days annually on the Monongahela River and 69 mg/l for an average of 241 days on the West Fork River when the reservoir release is greater than 100 cfs.	C.	1. Inundation of natural gas pipes which leaves the reservoir liable to underwater leaks.
	2. Decrease in acid concentration by 2.7 mg/l for a period of 168 days in the Monongahela River and 7 mg/l over a period of 277 days in the West Fork River when the reservoir flow is 150 cfs.		2. There is no increase in organic assimilation capacity because of the reservoir.
	3. The acid reduction will prevent corrosion to locks, barges, boats, and dams by the amount equivalent to $6,000 annually when the flow is 100 cfs.		3. There is double counting of some flood control and water supply benefits on the West Fork River because of the duplicating effects of the reservoir and two small watershed projects.
	4. Water temperature on the Monongahela River will be controlled by flow regulation such that annual benefit is equal to $11,000.		

If quality factors in consumption could be considered quantitatively, environmental quality would be included in the efficiency and equity accounts. Since empirical problems make this impossible, however, a display of the quality effects in physical terms provides supplementary information to the political decision-maker. With the display, accessibility to the decision maker is improved. The naturalist, the historian, the limnologist, and the research scientist are provided new access with respect to water development evaluation and decision-making.

ALTERNATIVE PLAN FORMULATION

With the introduction of Planning-Programming-Budgeting into the Federal Government in 1965, departments and agencies were required to perform substantial policy analyses when expanding an old program or requesting a new one. Apart from measuring effectiveness and estimating costs, comparison of alternative approaches to achieve given program objectives was required. Program objectives were often stated as a goal (to protect a flood plain, or to educate 1000 hard core unemployed) and either the least cost or most economically efficient method of achieving the goal indicated the direction in which one might move.[117]

The Water Resources Council Task Force Report on Evaluation Procedures has added a new dimension and much clarification to the process by which alternative means to a goal may be evaluated. By defining a type of social welfare function with four component parts, it has made explicit other welfare criteria, besides national economic efficiency, by which various courses of action must be measured.[118] Thus, the most efficient alternative means of achieving flood control can no longer be immediately deemed superior to all others.

Yet presently there appears to be no satisfactory "rule" by which alternatives can be limited and choices made between them. While the admission of a social welfare function with four component parts is useful, these parts are still not adequately defined, nor have tradeoffs between each component part been made explicit. This section will not

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[117] Keith E. Marvin and Andrew M. Rouse, "The Status of PPB in Federal Agencies: A Comparative Perspective" and Jack W. Carlson, "The Status and Next Steps For Planning, Programming and Budgeting," in The Analysis and Evaluation of Public Expenditure: The PPB System, Subcommittee on Economy in Government of the Joint Economic Committee (Congress of the United States, 1969).

[118] This form of the social welfare function has been highlighted by Marglin. See: Stephen A. Marglin, "Objectives of Water Resource Development: A General Statement", in A. Maass et. al, Design of Water Resource Systems, (Cambridge, Mass.: Harvard University Press, 1962) pp. 17-37.

attempt to develop this clear set of rules. The question will be not so much one of choosing the best alternative, but rather one of asking how enough alternatives can be presented so that the "wisest" course of action may be chosen.

Some Basic Definitions: Before proceeding, some definitions need to be presented. It should be emphasized that the conclusions drawn in this section hinge on these definitions. Discontent with the conclusions may very well stem from disagreement with the definitions.

Needs: As defined here, needs relate to a water function (flood control, recreation, wild river, etc.) and not to the four objective accounts - efficiency, regional income, environmental quality, and well-being. These needs are usually of a collective nature, that is the private market is either unwilling or unable to provide for them and the burden for their provision falls on government.

Alternatives: As discussed here, alternatives will mean alternative ways of providing for needs. It does not imply alternative ways of promoting, for example, regional growth.

Objectives: The four objective accounts defined by the Task Force are viewed as a means by which to measure the social welfare impact of the alternative ways by which needs can be provided.

The crux of the problem, then, is to accurately identify needs. There is no standard list. They are identified by our regional and national institutions.[119] However, the potential disagreement with these definitions is recognized. Maass and Major, for example, argue that in the past water resource investment decisions have been made with respect to objectives such as, but not limited to, national efficiency, and that this will continue to be the case in the future.[120] The argument that ultimate decisions on water resource investment have been made with respect to a multi-dimensional welfare function is agreed upon here. Yet the question still arises as to whether these project investments were made because of these objectives, or were measured by these objectives. While this may appear to be a semantic distinction, it has implications for alternative plan formulation and the entire decision process. If social welfare objectives are to be considered as goals by each agency,

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[119] Distortions in the institutional mechanisms, such as inordinate amounts of power in the hands of one group, may in fact lead to distortions in the definition of needs. For example, a small but powerful industry which requires water of a certain acid content may force pollution control measures whose costs exceed benefits to the society at large. While this problem will be alluded to again, it will not be discussed in much detail.

[120] A. Maass and D. C. Major, "Economics in Regional Water Research and Policy: A Comment," American Journal of Agricultural Economics (Feb. 1970).

then the Bureau of Reclaimation, for example, must consider not only alternative irrigation projects for regional growth, but also highways, education etc. Few would argue that this is a job for this agency. This agency should consider only the more proximate goal of providing for water requirements.

This distinction between needs and objectives is not made by the Task Force and, thus, the exact purposes of the report are unclear. The document states:

> In formulation of a comprehensive river basin plan and the program elements of the plan, two fundamental series of decisions are involved: (1) the choices among objectives and (2) the choices of alternative means to achieve these objectives. All appropriate objectives are to be considered in the planning process and one national objective should not necessarily be considered more significant than another objective. However, one objective may emerge with more weight than another in achieving the plan. The specific elements of the objectives to be considered should be stated at the start of the study and the plan formulated to achieve them. It is recognized that as planning proceeds there may be modification in objectives. Interrelations and combinations among and between means and objectives will be involved. The analysis and accounts described provide the basis for reasoned judgment about composition of the comprehensive plan, including the mix of objectives and the program elements to achieve them (underlining added).[121]

As Castle has stated, "it is difficult to visualize exactly how the system of accounts would work in practice."[122] This difficulty stems directly from the fact that the Task Force has neglected to define the area of concern for water resource agencies properly. They are concerned primarily with water needs not with overall national welfare objectives.

This viewpoint is admittedly a "conservative" view of agency purposes. However, it seems unlikely that water resource agencies were created to promote national income, or regional growth. More likely they were created to provide for water needs when higher level decision making authority felt that water was a constraining factor in achieving these ends. Furthermore, the agency, as a political group, is not for example pushing efficiency, but rather a water function like flood control. Its political constituency would be pro-flood control, not for any given welfare objective.

The plea here is for a higher level decision making authority to be the one concerned with highlighting the relevant social welfare ob-

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[121] Water Resources Council, Procedures for Evaluation..., 54-55.

[122] Emery N. Castle, Testimony Presented to the Water Resources Council Hearing in Portland Oregon, August 11, 1969.

jectives, and not the planning and construction agencies. This upper level decision authority may be composed of several groups. For example, the choice between highways or water for regional growth may be made by the present system of review conducted by the Bureau of the Budget and Congress.

It is not the intent of this discussion, then, to reconstruct the entire federal decision process. Yet with respect to water related decisions, it seems that a "beefed-up" Water Resources Council to measure alternative plans for providing water needs, by the social welfare function, is a needed change. In fact, it could be a coordinating agency to regulate competition between the diverse agencies engaged in water resource management. These ideas will be discussed in more detail later.

In summary, the Task Force report is titled Procedures for Evaluation of Water and Related Land Resource Projects, and not "Procedures for Evaluating Alternative Investments to Promote Social Welfare." It is the purposes of these projects - their functions - which are to be evaluated in terms of the social welfare function as defined by the Task Force report. To argue that the money spent on highways or education would be more beneficial for social welfare is beside the point in terms of this discussion. This sort of debate is of a higher level and less suceptible to quantitative analysis.

Some Approaches to Highlighting Alternatives: In view of the discussion above, the problem of limiting alternatives and presenting the decision-maker with a reasonable range of choice will be considered in this section. Some possible approaches which appear logical will be considered.

The Task Force's instructions for testing the proposed procedures suggest that "if feasible, at least one alternative plan should be formulated emphasizing each objective."[123] Consider the following situation as an example of what may happen if one presents a plan to maximize each objective account, however. The following assumptions are made. Those which are most critical to the conclusions drawn will be relaxed one at a time and their effects noted.

1. Two needs are defined.
2. Two plans, I and II, are presented, by a single agency or group, which will satisfy these needs.
3. Each plan maximizes one account.
4. Two objective accounts, A and B, are used to measure the welfare effects of the two plans.
5. All aspects of accounts A and B can be quantified.
6. There is a 50-50 tradeoff between objective accounts.

Examination of Table 19 reveals that plan I maximizes account B and plan II maximizes account A. Total net benefits for plan II exceed those for plan I and, therefore, plan II must be chosen.

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[123] Water Resources Council, "Instructions for Testing," 7.

TABLE 19

MULTI-OBJECTIVE ALTERNATIVE PLAN EVALUATION AND DISPLAY

Objective Account	Plan I			Plan II		
	Benefits	Costs	Net	Benefits	Costs	Net
A	100	50	+50	70	10	+60
B	60	50	+10	95	90	+5
Total Net Benefits			+60			+65

However, examination of Table 20 shows that if a plan III is considered which maximizes neither account, it may be superior to either plans I or II. Therefore, maximizing each account and making a choice from these

TABLE 20

BENEFIT AND COST DISPLAY OF PLAN III

Objective Account	Plan III		
	Benefits	Costs	Net
A	79	20	+59
B	89	80	+9
Total Net Benefits			+68

alternatives ignores the existence of possible second best solutions. Thus, a wider range of alternatives must be kept open up to the point of final decision making.

Now, however, some of the assumptions which underlie this decision model are relaxed. If assumption number six, from above, is removed and no weights are known or given a priori, the whole design of the decision model becomes unworkable. If one is unable to rank objectives a priori, there is no way to determine whether an alternative which is second best under all categories is in fact the most desirable. Even more to the

point, there is no way by which any alternative can be measured for its total social welfare effect. These weights are viewed here as outputs of the political process and, as such, vary from decision to decision and time to time in an unpredictable fashion.

It has been suggested elsewhere, however, that some set of weights based upon "consideration of legislative intent, guidelines established in law and precedent and ultimately subjective evaluations by politically responsive decision makers" can be arrived at which will allow tradeoffs among multiple objectives to be made.[124] If a weighting procedure were possible, or allowable, then relaxation of assumption six would result in replacement of the weights assumed with some others rather than abandonment of weights altogether.

If one is willing to say that weights are a higher level decision, not related to concrete decisions made each day, then weights can be assigned a priori.[125] However, this type of assignment for welfare weights (with respect to the environment in which the ultimate results of programs and projects will have impact) may not lead to a maximization of social welfare. For example, regional growth may be ranked higher than environmental quality as a national priority, but if a region finds itself bursting with industrialization and population and plagued by water pollution, the national ordering of priorities makes little sense when evaluating alternative means of pollution control for that region.

One phrase in Freeman's procedures for assigning weights stands out - "subjective evaluations by politically responsive decision makers."[126] Politically responsive to whom? It would seem that responsiveness should be to those who have a stake in the decision as well as to some national social welfare function. The point being that defining weights for a social welfare function with no reference to a concrete region or plan may just as easily serve to decrease welfare as to increase it.

It has been shown that relaxing the assumption that welfare weights are known destroys the procedure for limiting and choosing among alternatives. However, since some have argued that weights can be defined, can it then be argued (by accepting this assumption) that a decision procedure like that outlined above becomes possible?

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[124] A. Myrick Freeman III, "Project Design and Evaluation with Multiple Objectives," The Analysis and Evaluation of Public Expenditures: The PPB System, Vol. 2, Subcommittee on Economy in Government of the Joint Economic Committee, (Congress of the United States, 1969) p. 565. A similar suggestion has been made by Musgrave. See: R. A. Musgrave, "Cost-Benefit Analysis and the Theory of Public Finance," Journal of Economic Literature, Vol. VII, (September, 1969) p. 803.

[125] Musgrave suggests this approach. Weights on each objective would be determined by the Bureau of the Budget or a similar agency and then used on all government programs. Ibid.

[126] Freeman, 565.

Relaxing assumption number five, that all aspects of all objective accounts can be quantified, has the same effect on the system as assuming non-quantifiable weights. The choice of a best plan becomes indeterminate. The problems and inability to quantify many aspects of a given project or program are highlighted elsewhere in this report. Given this limitation, value judgements (albeit expert ones) must be made on the effect any plan may have on any one objective account. As with weights, these value judgements are subject to challenge depending on how the valuation of perceived benefits differs between individuals, groups, or agencies.

This idea of different perceptions leads to a consideration of assumption number three, that a finite number of alternatives can be determined and accurately analyzed by one agency or group. Without going into the varied models of decision making, let it be suggested that truly comprehensive planning by one group is not possible.[127] It is assumed here that decision makers and decision points are many and diverse, and that these decision makers each have limited knowledge of the alternatives open to them. Furthermore, even if they are aware of alternatives, they are often not empowered legally to implement them. For example, the Army Corps of Engineers can not consider treatment plants as an alternative means of pollution control, nor are they likely to consider flood plain zoning as an alternative for flood control. Both are beyond their areas of jurisdiction. Therefore, many plans, including second best ones, may escape detection unless there is some way to bring "all" possible alternatives into the decision process.

The relaxation of assumptions has destroyed the use of the decision framework set up earlier for empirical analysis. Yet the basic operation of this framework is a conceptual ideal. It, therefore, becomes necessary to propose some sort of procedures which will approach this ideal. While the evaluation procedures in the Task Force report are couched in economic terms (i.e. benefits and costs), the formulation of alternative plans must go beyond the purely economic, just as social welfare goes beyond economics. Alternatives which maximize social welfare must be defined in the same way as social welfare - by a group process not by academic disciplines.[128]

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[127] For a standard treatment of this question, see: Charles Lindbloom, "The Science of Muddling Through," Public Administration Review, Vol. 19 (Spring 1959).

[128] For further discussion of this point, see the section on institutions in this report. It must be noted here that attempts to quantify weights or values for intangibles, or to state group preferences in terms of some set of preference functions may be possible. However, the cost of acquiring this type of information would be high and, even if one were to build up a backlog of information, there is some question as to how useful it would be for making future decisions. Certainly politically sensitive and responsive groups of decision makers should be able to anticipate what values or weights would make sense with respect

The Role of Group Pluralism in Defining Alternatives: Needs are articulated by groups in the political process. These needs are then presented to other groups (here government agencies), empowered to satisfy the needs. In the satisfaction of these needs, new groups come forth whenever conflict arises over the satisfaction of the original needs and their vested interests. Through a process of partisan mutual adjustment (a la Lindbloom), a compromise is struck which all groups can be at least partially satisfied with. So runs the basic model of the group process in water resource management at the governmental level. In fact, this basic model, in the past, has often failed because there was no point in the system where some groups could find access very easily.[129] As a result, single agencies have often taken it upon themselves to define needs, propose alternatives, choose among them, and implement the plan chosen. They have internalized the whole process. In so doing they have limited the system's usefulness for defining the public interest, since agencies themselves can be considered interest groups and the alternatives presented are limited to those acceptable to this group.

The WRC document offers three new points of access. By effectively using these three additional access points, both government agencies and private interest groups which previously were excluded from plan formulation, except at the point of reacting to proposed plans, can be incorporated more effectively into the planning process. In this way, they bring new ideas and new expertise to the problems of planning for water needs. In short, they bring alternatives. It should be clear by now, that the question of alternative plan formulation is viewed as being intimately related to the power of groups with different points of view to get these views into the planning process. Any proposals for a system by which alternatives can be formulated will be based upon a healthy group system.

The Relevancy of the Objective Accounts: One other problem, which relates to the question of alternative plans formulation, will now be addressed. The Task Force asked the test teams to "address the relevancy

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to the objectives of the interests involved in any given situation, without reference to valuation of intangibles or preference functions. A politically sensitive decision maker, then, would have little use for quantitative formulations and descriptions of the group political process which he already has a feel for.

[129]There are other reasons why this process may be inadequate. Some maintain that this model of group pluralism can not lead to maximizing social welfare even if access is improved. They maintain that the process itself is devoid of objectives and procedures which are universally accepted and so leads to non-optimum definitions of the public interest. See: Theodore Lowi, The End of Liberalism (New York: W. W. Norton and Co., Inc., 1969). In fact, the political process is presently working through groups and, in this report, a radical change in the group process is not suggested. Along these lines, however, improvement in access to agencies for groups and other agencies seems to be a change at the margin which could be quite useful.

of the several national objectives for the area under study and determine which ones should be considered for plan formulation and which ones could be rejected and the reasons for rejection."[130] The Task Force provides the analyst with four objective accounts by which to measure social welfare: National economic efficiency, a regional account, environmental quality and well-being. Without trying to identify all the fine points of each account, it will be useful to address the question of how the national efficiency account relates to the others.

It has been suggested elsewhere that economic efficiency is not so much an ultimate goal of society as it is a means to an end.[131]

> Economic growth appears. . . in a supporting role to higher objectives of man. It is not likely however that such ultimate goals can be achieved when the production of economic wealth in a society is at a low level. As the production of economic wealth increases, the extent to which improved efficiency, if measured by an increase in national income, can be used to achieve these more ultimate goals may decline.[132]

There is little question that the United States has achieved growth levels where the role of economic efficiency as a goal has less weight in a social welfare function.

> As national income improves the importance of extra-market goods, which are not normally included in improved national income, increases. It is not that economic efficiency loses importance; it is simply that the traditional ways of measuring it do not bring into the open the items of greatest relevance.[133]

These extra market goods can probably be classified as improved regional and personal income distribution, improved environmental quality, improved population distribution, etc. All these fit under objective accounts other than national efficiency in the Task Force Report. If indeed these extra market goods do now command a higher position in our society than increased national income, the accounts which incorporate extra market goods will receive greater weight when analyzing alternative means of supplying water needs.

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[130] Water Resources Council, "Instructions for Testing," 7.

[131] Emery N. Castle and Russell Youmans, "Economics in Regional Water Research and Policy," American Journal of Agricultural Economics, Vol, 50 (Dec. 1968).

[132] Ibid. 1662. Gailbraith suggested this same sort of approach. He suggests that more goods and services may not be as desirable a goal as better use and distribution of the goods and services we already have. See: John K. Galbraith, The Affluent Society (Boston: Houghton Mifflin Co., 1958).

[133] Castle and Youmans, 1663.

Still one must return to the point made earlier, that economic efficiency remains important as a measurement of the means by which given ends are achieved. Since planning for water needs is the primary purpose to which we must address ourselves, it is better to satisfy these needs more efficiently than inefficiently provided that the desired criteria set forth in other components of the social welfare function have been satisfactorily met. Varying amounts of national income gain may have to be sacrificed to achieve other aspects of the social welfare function, and this is recognized.

The determination of the weights necessary to make the tradeoffs among the various criteria making up a social welfare function takes one beyond the realm of economics. The task once more must fall on our institutions and political system. While the economist has a clear role in this system, he alone can not define a social welfare function - the "public interest."

Conclusions and General Model of Procedures for Formulating and Evaluating Alternatives: While this section is titled "Alternative Plan Formulation", in fact it has not developed procedures for doing this, and only a few brief suggestions will be made toward this end. The reason for this is two fold. First, it seemed a more useful endeavor to draw the distinction between water needs and social welfare objectives, and then to clarify the position of the objectives within a social welfare function. Secondly, and most importantly, it seemed useful to demonstrate that the introduction of a multi-dimensional social welfare function has effectively limited the role which quantitative economic analysis can have in defining and choosing among alternatives. In view of this, the word "procedure" takes on new meaning. Procedures now must mean parameters of action for the group process as well as the proper definition of benefits and costs. Some of these ideas will now be loosely tied together to indicate the direction the new "procedures" for formulation and evaluation of alternatives should take.

A Criteria for Limiting Alternatives: It has been argued previously that the purpose of water resource development is to provide for water needs. It was also assumed that a priori weights for a social welfare function cannot be quantitatively determined at this stage in history to assist in the choice among alternatives. Because of this situation other, more proximate, decision models must be used. It will be proposed that alternative projects which provide for water needs should be considered (initially) only if their benefit-cost ratio exceeds unity, and each alternative is analyzed with respect to the other objective accounts to gain information on each component of the welfare function. Implicit in this statement is the assumption that if no efficient means of satisfying the water needs can be found then it may be wise to question the existence of these needs. It, of course, must be noted that one can envision a situation where the efficient means of supplying needs has an undesirable effect on the other objective accounts. If the needs are reexamined and one still wishes to provide for them, then an inefficient means may be utilized. Thus, one would be willing to sacrifice national income for the other objectives.

The main point of this section, then, is that using a benefit-cost ratio greater than one as a cut-off criterion for alternatives is acceptable. At any point in the decision process a plan may be rejected due to, say, adverse environmental effects, and at this point it may be necessary to offer a plan which is inefficient. Thus, the presentation of alternatives may be a process with more than one round. To limit first round alternatives to those having a benefit-cost ratio greater than one is as good a criterion as is available given our lack of knowledge. We are in effect muddling through.

Another advantage of using the benefit-cost ratio as a cut-off criterion relates to the role of efficiency as a measure of means and not an end. By formulating the most efficient plan, and then all others, the cost of choosing other than this most efficient plan can be approximated by noting the reduction in net national efficiency benefits from choosing a less efficient plan. This opportunity cost concept can be used to give an accurate measure of the costs of choosing one plan over another. These will be costs in the traditional economic sense.[134] There would also be costs to other objective accounts. Choosing a plan which has beneficial effects on environmental quality may mean forgoing some income redistribution benefits. These costs are also recognized, but are not subject to quantification as are national income gains or losses.

An exact procedure for formulating and evaluating alternatives can not be defined here. The nature of the group process which will formulate alternatives must itself be determined by the group process. One can envision, however, two polar types of alternative plan formulation under the auspices of a strengthened Water Resources Council. One type of planning forces inter-agency competition, while the other puts a premium on extensive cooperation and coordination. As may be guessed, the ideal group process must lie somewhere between these two extremes.

The competitive model would work as follows. Given the definition of needs,[135] the Water Resources Council would examine their nature and choose the appropriate agency or agencies to study the problem and propose a plan for their satisfaction. In all cases the proposed plan must be rational from the agency's frame of reference. For example, the benefits must exceed the costs of any flood control proposal. It is recognized that for achievement of aesthetic goals (like a wild river), the "best" plan must be one based on expert judgement not a benefit-cost calculation.

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[134] These views are developed fully by Castle elsewhere. See: Castle, Testimony, 4-7.

[135] The whole problem of need definition which was alluded to earlier is glossed over here. How the preferences of individuals or groups can be accurately reflected in the political process is a problem of major importance and is vital to the proper working of any system of resource planning.

Upon completion, the plan(s) would be submitted to agencies previously alerted by the WRC. They would do studies on the three objective accounts which were not of concern to the original planning agency. For example, upon completion of a Corps plan for a flood control dam, the Fish and Wildlife Service and the relevant regional development commission would evaluate the impact of the project on the environmental, regional growth, and well-being accounts.

It is not the intention here to convey the impression that all agencies (especially those concerned with national income) must by definition be indifferent to all objective accounts other than their own. For example, the Corps can have a biologist to advise them, but this does not mean that they do the environmental analysis.

The results of the analysis of all the objective accounts are, then, put into a display and the Water Resources Council decides whether the specific plan has undesirable effects on social welfare. If it does not it is recommended to "higher authorities" where the decision on funding water projects vis-a-vis all other spending programs is made. If it is not a suitable plan, the agency who originated it is asked to propose the next most rational plan from their viewpoint (next highest B/C ratio) and the whole process repeats itself until some plan is found which in some sense maximizes social welfare. As one moves from say the most efficient plan to some other in order to meet other welfare goals, the opportunity cost of national income forgone by choosing the alternative plan can be highlighted.

Basically, then, agencies compete with one another to have their idea of what makes up social welfare accepted by the WRC. Acceptance of certain projects and project modifications by the WRC reflects a successful effort by the agency or agencies backing the project and its modifications to persuade the WRC of their view of what the social welfare impact of the project would be.

At the other extreme is complete agency coordination. In this case, the WRC would choose an agency to represent each social welfare objective as well as the agency which is to propose a plan to meet the water related need. They would all cooperate to propose alternative plans to meet this need. Thus, the expertise to highlight social welfare objectives would be present when the initial plans were formulated. The resulting plan would be the product of consensus and not competition between agencies.

Both the models above have flaws. The competitive extreme would produce a vastly complicated and costly planning process, although like the perfectly competitive market ideal it would no doubt lead to "good" results. The model of coordination would reduce the complications and cost of planning significantly but perhaps at the expense of social welfare. To argue that agencies represent social welfare objectives is probably an oversimplification of reality. Agencies in fact represent clientele groups who demand certain goods and services which in turn reflect social welfare objectives. While the competitive model would tend to keep agencies responsive to clientele groups, the model of com-

plete coordination creates the danger that the cooperating agencies may become more responsive to each other than to the groups and social welfare objectives that they must represent.

The conclusion which arises from the above discussion is only that there is some optimum mix between agency coordination and competition in the planning process. The proportions of each must be determined by trial and error and the success of planning measured by how well the "public interest" is served.

Essentially what has been discussed up to now is organization chart manipulation. While this is necessary to indicate how things ought to work, the existence of such procedures does not guarantee that is what will happen. A crucial issue in the planning process is who has power. For there is a definite relationship of power to organizational structure. Varying levels of power do allow one to disrupt the organizational structure to varying degrees. For example, the financial and institutional position of the Army Corps of Engineers allows them to circumvent existing lines of authority more easily than the National Park Service or Fish and Wildlife Service would be able to.

Related to the question of power is that of access to the planning process. Implementation of the Task Force Report would certainly provide this access to many groups which may have previously been excluded. This is a step which can lead to a balancing of the power relationships which now exist in water resource management. Another useful step would be to channel all funds for water resource development through the WRC and permit the agencies to compete for these funds and for new roles.[136] This would force more equitable power relationships between the different agencies and, therefore, between the clientele groups and social welfare objectives they represent.

In short the proposal and evaluation of alternative plans to meet water needs must be a mix of agency coordination and competition in an atmosphere of equitable power relationships. Some further general points flow from this analysis:

1. The process by which projects and plans for water resource development are approved will not be changed. Federal programs will go from the WRC through the Bureau of the Budget, and localized interests may resort to congressional activities to get their viewpoints heard, once the planning stage is over.

2. Accounts are not definable by agency lines. Therefore, the agency in charge of each account may vary from project to project. This may cause problems. If one agency is utilized a great deal more than

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[136] This idea of interagency competition is discussed in: David J. Allee, "Coordination of Agency Activities," A paper presented to the Symposium of the Statewide meeting of the U. S. Soil Conservation Service, Syracuse, N. Y. June 21, 1967.

others, it may develop disproportionate powers. It may in fact be necessary to set up boards concerned with each account which then in turn can farm out work to subordinate agencies. These boards could be of equal stature and power.

3. The purpose of the new procedures is to prove to agencies such as the National Park Service, the Fish and Wildlife Service, or regional development boards, that they must take on a more active role in plan formulation. In the past, they were put in a position of always reacting to proposals with high benefit-cost ratios. Now their line of expertise and interest is being highlighted and they have become full partners in the system of plan formulation.

4. The WRC must be staffed with a significant number of people who have no vested interest in one agency's program over anothers. These people should also have no interest in federal programs over state or local programs. This may be asking for a great deal but it is a goal worth striving for. It should be expected that personnel in the WRC would have lobbying pressure placed on them and not on the planning agencies. This is, in fact, how they must make their decisions - in response to the group process.

5. These procedures as outlined above admittedly ignore one of the crucial problems in water and land resource management, that of coordinating local, state and federal programs and plans. This problem is of major proportions and it is not clear how the Task Force Report attempts to remedy it.

No rules have been introduced for planning alternatives because the Task Force Report should not provide such rules. It is a political, as well as economic document, which has made an attempt to provide some method of determining the public interest. The following statement by Steiner relates these two uses of the Task Force Report and serves quite well in summarizing the thrust of this section.

> Obviously the question "What is the public interest?" has no simple answer. Indeed asking the question invites the sort of smile reserved for small children and benign idiots. . . . There is a role for measurement, a role for analysis, and some need for explicit decision making . . . One of the economists' most potent functions is to honestly identify what can be accurately measured and compared and what (on the other hand) involves such heroics of assumption that actual measurements are but concealed preferences. The advantage of articulating real choices over assigning measures that appear to obviate them is to make the decision explicit and subject to review. <u>But having identified the scope for explicit choice does not mean public administrators have unconstrained choice. Within particular dimensions departures from the efficient solution ought to be identified and justified</u>. (emphasis added)
>
> Clearly all sorts of decisions do get made and not all of them are sensible . . . (but) . . . I should be willing to re-

gard open decisions arrived at by elected (or otherwise responsible) public officials as a reasonable approximation of the collective values we call the public interest.[137]

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[137] Peter O. Steiner, "The Public Sector and the Public Interest" The Analysis and Evaluation of Public Expenditures: The PPB System, Vol. 1, Subcommittee on Economy in Government of the Joint Economic Committee (Congress of the United States, 1969).

APPENDIX 1

COST ALLOCATION[a]

Annual Costs
Multi-Purpose Project (1 omitted)

		Project Total Costs	Water Quality Omitted	Water Supply Omitted	Flood Control Omitted	Recreation Omitted
I)	Investment:	33,486,000	33,315,000	33,486,000	28,275,000	31,124,000
	Construction Expenditures					
	Interest during Construction	2,450,000	2,436,000	2,450,000	2,068,000	2,276,000
	TOTAL INVESTMENT	35,936,000	35,751,000	35,936,000	30,343,000	33,400,000
II)	Annual Charges	1,752,000	1,743,000	1,752,000	1,479,000	1,628,000
	Interest & Ammortization	31,800	31,600	31,800	26,900	29,600
	Operating & Maintenance	146,700	145,400	146,700	146,700	56,700
	Major Replacements	17,000	17,000	17,000	17,000	----
	TOTAL	1,947,500	1,937,000	1,947,500	1,669,600	1,714,300

[a]Used to determine separable cost for separable cost-remaining benefit method of joint cost allocation. Separable cost of water quality was allocated to water supply.

APPENDIX 1 - CONTINUED

SINGLE PURPOSE PROJECT[b]

	Flood Control	Water Quality	Water Supply	Recreation
I) Investment	23,785,000	24,724,000	2,191,000	------
Int. during Construction	1,739,000	1,808,000	130,000	------
TOTAL	25,524,000	26,532,000	2,321,000	------
II) Annual Charges	1,244,000	1,293,000	113,000	------
Int. & Ammortization	22,600	23,500	2,100	------
Operation & Maintenance	55,400	56,700	7,000	------
Replacements	----	----	---	------
TOTAL	1,323,000	1,373,200	122,100	336,000

[b]Used to determine alternative cost and benefit limits for separable cost-remaining benefit method. Water supply and quality are combined in the subsequent calculations.

APPENDIX 1 - CONTINUED

ALLOCATION OF PROJECT COSTS

SEPARABLE COST-REMAINING BENEFITS METHOD

Annual Costs, $1,000	Flood Control	Water Supply	Recreation	Total
1.) Benefits	765.0	191.9	479.0	1435.9
2.) Alternative Costs	1323.0	1494.3[c]	336.0	3154.3
3.) Benefit & Limits	765.0	191.9	336.0	1292.9
4.) Separable Costs	277.9	10.5[d]	233.2	521.6
5.) Remaining Benefits	487.1	181.4	102.8	771.3
6.) Allocation of Triple Costs				
(6a) Remaining Benefits	-----	181.4	102.8	284.2
(6b) Ratio-Line 6	-----	.64	.36	1.000
(6c) Allocated Triple Costs	-----	243.7	137.1	380.8
7.) Separable & Allocated	277.9	254.2	370.3	902.4
8.) Remaining Benefits (Line 3-Line 7)	487.1	-62.3	-34.3	390.5
9.) Ratio-Line 8	125%	-16%	-9%	1.000
10.) Allocated Joint Costs	1306.4	-167.2	-94.1	1045.1
11.) Total Allocated Costs	1584.3	87.0	276.2	1947.5

[c]Since the water quality component is omitted, the alternative cost of water quality is allocated to water supply.

[d]Separable cost of water quality is allocated to water supply.

APPENDIX 1 - CONTINUED

ALLOCATION OF PROJECT COSTS

SEPARABLE COST-REMAINING BENEFITS METHOD

Annual O & M Costs	Flood Control	Water Supply	Recreation	Total
12.) Separable Costs	0	1.3	90	91.3
13.) Allocated Joint	69.3	-8.9	-5.0	55.4
14.) Total Allocation of Costs	69.3	-7.6	85.0	146.7
15.) Separable Costs	0	0	17.0	17.0

(1)

Project cost	$1947.500
Reservoir for Flood Control	- 1323.000
Cost of adding water supply and recreation	$ 624.500
Less assigned separable cost:	
10.5 233.2	- 243.700
Cost to be allocated to water sup. and recreation	$ 380.800

APPENDIX 1 - CONTINUED

COST ALLOCATION ($1,000)

Allocation of Investment Costs	Flood Control	Water Supply	Recreation	Total
16.) Investment Costs (Line 11-14)	1,515.0	79.4	267.7	1,862.1
17.) % Line 16 to total Line 16	81%	5%	14%	
18.) Allocated Investment	29,108.2	1,796.8	5,031.0 490.0	35,936.0
19.) TOTAL	29,108.2	1,796.8	5,521.0	36,426.0