The Basics of Benefit-Cost Analysis

by

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FOREWARD

This paper has been in the making for the past two years. It incorporates ideas from seminars, interviews and unpublished papers in the Federal Public Service as well as from the general literature. The resulting information has been condensed into a form that presents the basic concepts in the field of benefit-cost analysis without being too detailed for the decision maker nor too diluted for the analyst.

We welcome comments and questions from readers of this paper. Your comments will be most useful in the preparation of future studies. As for questions, we would be pleased to further clarify or elaborate on any of the points covered or on any other related points.

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THE BASICS OF BENEFIT-COST ANALYSIS

INTRODUCTION

This paper is intended to provide a quick review of the principles and concepts of benefit-cost analysis as it is currently practiced. It is a general study of the field and is by no means exhaustive. It should also be stated that the object of the paper is a state-of-the-art review rather than one of argument. Therefore several of the more controversial aspects of this topic have been left for discussion in later papers.

Before looking at the technique of benefit-cost analysis in detail, let us first consider the overall context. The decisions that must be made by any organization will depend on the goal or goals of the organization in question. These goals imply the maximization of something. A general term to describe this something is utility. Thus every organization (and every individual) in our society is striving to maximize utility. What this utility is varies according to the nature of the organization. For business organizations it is usually assumed to be profits. For an individual person it is usually equated with satisfaction. In government agencies, utility becomes the well-being of the people or social-welfare.

The main interest of this paper is in the approach and procedures to be used by a government agency. Unfortunately the concept of social welfare and its maximization is a vague, ill-defined concept compared to something like profits. The social welfare concept

must take into account all the goals of the people, both as individuals striving to maximize their satisfaction and as members of organizations striving to optimize some form of utility. These various goals will often be in conflict and at times, mutually exclusive. Furthermore there is nothing comparable in government to the price mechanism of the business world which tends to automatically allocate resources so as to ensure efficiency. Hence, there is a need for a compensating technique in the government sphere.

One such technique is benefit-cost analysis. Benefit-cost analysis can be defined as a practical, methodologically sound and quantitative means to compare the output (benefits) and input (costs) of a particular project or program. It can be used:

(1) to assess the economic feasibility of a project or program, that is, to ascertain if the benefits at least justify the cost; and

(2) to assist in ranking alternative projects or programs in terms of their rate of return or net benefits to society; in other words, it can be used to determine which project gives the best ratio of benefits to costs, or the greatest amount of net benefit, or both.

Furthermore, by using the benefit-cost ratio one can evaluate not only the projects of similar types of individual agencies, but to a certain extent, all projects of the government. However, this is not meant to suggest that one would use this type of criterion

exclusively. For example, if education projects were shown to have lower benefit-cost ratios than any of the water resource projects this would not mean that we should eliminate all educational programs. However, such results would make the "strategic" decision makers aware that the returns on educational projects were lower than the returns on water resource projects at that particular time as far as this could be measured and thus they would have some idea of the relative magnitudes involved. They must, of course, consider many intangible factors in these cases (some of which may have been brought to their attention by the analysts themselves).

Another point that should be mentioned here is that knowing the costs of the projects and programs proposed for an agency coupled with their rankings in terms of social utility is a great help in the preparation of the agency's budget.

Benefit-cost analysis is therefore a most useful device; but it cannot be stressed too highly that it is not the whole answer to any problem that may confront a government agency. It is primarily an economic analysis within a given framework. This last statement implies two key limitations. First, it deals almost exclusively with economic considerations, leaving out social and political aspects of the problem such as redistribution of income and promotion of national identity, which may be much more important factors in the decision than the economic efficiency.(1) In addition, the analysis is limited by the sphere of reference of the analyst. For example, if a public investment decision is large enough to affect output and prices in the economy then benefit-cost techniques will not be sufficient; (2)

other techniques such as simulation modelling will be needed.

It follows then that in order for the decision maker to properly utilize the results of this technique, he must become thoroughly acquainted with both its potentialities and its limitations. He should also understand the main problems and issues relating to the technique (such as the place of secondary benefits and the importance of the discount rate) and be generally familiar with the state-of-the-art.

In reading this paper, reference should be made to the flow chart (see insert) which shows the general pattern of a benefit-cost analysis.

We will now proceed with the step-by-step process of benefit-cost analysis as depicted in the flow chart and described in sections one to four.

1. ANALYSIS OF OBJECTIVES

The first step of a benefit-cost analysis is to ascertain the exact nature of the project objectives. The analyst cannot even begin to postulate solutions or compare them until he has a clear definition of the problem or problems at hand. This may seem too elementary to even mention but it is much too important to disregard.

A government agency should have one or more general objectives defined in its term of reference. These may predetermine the objectives for the analyst. However, they will often be too vague. The decision maker may himself define the specific objectives, but should he not do so then it is up to the analyst in discussion with the decision

maker to recommend possible objectives, and to refine these to specific aims.

The general objectives may originally be derived from any one of a number of sources. There may have been a special committee from within an agency or from among several government departments set up to ascertain the objectives. Or the objectives may come from the cabinet or a cabinet committee, from Parliament or a Parliamentary Committee, or from a special agency such as the Economic Council. The exact source is not important; the important thing is that both the decision maker and the analyst have established a specific objective or set of objectives before the analysis begins.*

Along with an objective or set of objectives there will be one or more constraints. Constraints are very closely tied to objectives for without them there would be no need for a benefit-cost analysis. One would merely choose the first project which would fulfill the objectives - end of problem. However, constraints exist whether we care to admit their existence or not. For example, there are legal and technical constraints, as well as budgetary and administrative constraints. One could also mention political constraints, however, these will not be covered herein. Some of the constraints mentioned, such as legal and technical, may seem rather obvious; nevertheless, they have been included as separate steps in the benefit-cost process, as can be seen in the flow chart. This

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* A possible problem should be noted here. By approaching the analysis from the objectives of the agency, the results may be optimal from that agency's viewpoint, but be far from optimal from the standpoint of government or society as a whole. Hence, there is a need for benefit-cost analyses at all levels in the hierarchy of government.

is done to stress the fact that the analyst should ensure that any projects he undertakes are both legally and technically practical as well as politically feasible before beginning the study, otherwise he is wasting his time.

The administrative constraint can be defined by the nature of the agency involved. Most agencies have limitations on their goal setting. These goals may be set by statute or regulation or merely by current government policy (this latter case being more of a political constraint). Thus decision makers in such agencies must look for their objectives within their defined sphere of operations or frame of reference. For example, an agency such as Central Mortgage and Housing Corporation has to confine itself to projects that concern housing or mortgages. The Fisheries and Marine Service of Environment Canada is likewise confined to matters relating to the fisheries and marine waters of this country and their management.

The budgetary constraint is a major one as there are usually limits to budgets of individual agencies. As well, there is an overall budget constraint on the government although it is more flexible than in the case of an individual agency. Budgetary constraints may also be geographical in nature or apply according to project type. In any case, the budgetary constraint is of special importance to the benefit-cost analyst, for without it, his job would be a relatively minor one. If funds were unlimited to both the government and its individual agencies, then great care would not have to be taken in selecting the various projects. However, since in reality the supply of resources available to the government at any given time is limited, some measure of efficiency must be introduced.

2. POSTULATION OF ALTERNATIVES

Once the analyst has clearly stated the objectives, the next step is to postulate alternative solutions. It must be assumed that the analyst has available at this time both technical and legal assistance to help study the area under consideration. Then the analyst must, as shown in the flow chart, eliminate all the alternatives that are legally and/or technically not feasible.

An alternative solution may be either a project or a program. A project is a single undertaking designed to achieve an objective or a set of objectives and a program is a number of projects or a number of undertakings designed to achieve an objective or a set of objectives.

If for technical or legal reasons, only one project appears to be a possible solution, then the whole analysis becomes merely a test of economic feasibility - in other words, the problem is to determine if the benefit-cost ratio is one or more, or is equal to or greater than some predetermined ratio (this predetermined ratio is always greater than one, possibly some ratio such as 1.5). If there is more than one remaining project, the next step is to proceed with the alternatives that have not been considered, listing their benefits and costs, and ranking them according to various criteria. The flow chart shows this general case.

Thus we have assumed that the analyst has studied all the technical and legal material available and is now ready to collect the economic data for each remaining alternative. This leads us to the next section which corresponds with the box "Collect..." in the flow chart.

3. BENEFITS AND COSTS

Benefits are defined as any good or service which contributes directly or indirectly to the achievement of one or more of the objectives of the society. Costs, in turn, refer to any loss of a good or service, if that good or service could have been used in some alternative way to further one or more of the objectives of the society. It follows that in a benefit-cost analysis we are merely attempting to ensure that the utility to be gained through any project or program is as great or greater than the utility that must be foregone.

As can be readily seen in the flow chart, from the collection of data on the alternatives we proceed to a separate detailing of benefits and of costs. Both benefits and costs are then broken down into their component parts.

Benefits are classified as either tangible or intangible. Tangible benefits are further broken down into primary and secondary classifications. A similar classification breakdown also applies to costs. Although tangible benefits are usually considered more important in a formalized cost-benefit approach; the intangible items may be the deciding factor when the tangible benefit-cost ratios are close.*

Looking at the cost side of the picture the flow chart shows that the cost stream has a parallel structure to that of the benefit stream. These component parts shall also be discussed along with the corresponding benefit classifications in the sections that follow.

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* There are quantitative methods that can be used to assist in evaluating intangibles. One method we will discuss in a forthcoming paper.

However, one item on costs should be mentioned here - this is the matter of historical costs. Historical costs refer to the costs of projects or programs that have already been completed. These costs, which are now "fait accompli", are not under any circumstances to be considered in the cost stream of a current benefit-cost analysis. The benefit-cost analyst is not interested in justifying expenditures on past projects; he is trying to provide the decision maker with criteria for making decisions in the present for the future benefit of society. However in the situation where one is attempting to improve upon an existing project or is somehow incorporating an existing project into one's plans, one cannot ignore the historical fact. In this case one considers only the incremental costs (and benefits) that are incurred by the utilization of the existing project.

A practical situation that could conceivably arise is a case in which one has to weigh the feasibility of constructing a completely new project from scratch, or of enhancing an already existing structure. In such an analysis, one would consider the new project alternative in the conventional benefit-cost manner. In the case of enhancing the existing project, one would consider what costs would be foregone to achieve sufficient additional benefits (that is, over and above the existing benefits) to meet the objectives of the decision maker.

Another important concept to be mentioned is that of economic life. Most projects amenable to benefit-cost analysis consist of one or more physical structures which have a physical life expectancy.

Physical life refers to a period of time over which a structure continues to operate and perform its original function, for example, to generate a given amount of electrical power, with only reasonable or normal levels of maintenance and repair. The expectation for the physical life of the project should be made available to the analyst through the technical reports on the project. If it is not given, the analyst, in the case of a fairly common place structure, such as a sewage treatment plant or a dam, can apply a general rule-of-thumb estimate (e.g. 35 or 50 years) which will be adequate for his needs.

The analyst is more concerned with the economic life of the project. Under no circumstances will the economic life ever exceed the physical life. It may be the same; but more often than not, it is shorter than the physical life of the structure. A simple definition of the economic life of a project would be the period of years over which the benefits arising from the project exceed the costs attributed to it. This must be considered at best a minimal definition. A more exact definition would be: the economic life of a project is that period in which the benefits arising from it will not only exceed the costs involved but will also exceed those costs by a greater amount than would be possible in any other feasible alternative. This latter definition has added the concept of obsolescence. Thus, if a presently operating sewage treatment plant costs more to maintain and operate than a new one of the latest design (with its capital cost spread over its expected economic life), then the rational thing to do is to replace the old plant even if it has a remaining physical life expectancy of thirty or more years.

The important thing to remember is that an economic life must be estimated for each alternative that is considered. This is necessary so that the fixed costs can be spread over time, in other words, on a per annum basis. This means that the initial capital costs which go into building a hydro-electric dam, a sewage treatment plant or the like, will be spread over a period of years, e.g. 50 years, 35 years, 25 years, etc. Thus, if the initial capital investment amounts to $100,000, and the economic life is estimated to be twenty-five years, then, without considering the discount rate, one could allocate $4,000 as being the capital or fixed costs "per annum". Added to this would be the variable costs (operating and maintenance costs). This then yields the total annual costs which can be compared to the annual benefits that accrue during the life of the project.*

An important point to make here is the fact that estimations of economic life after a certain length of time (e.g. over 50 years) are so uncertain that it becomes useless to even consider them. This will be discussed further under the section of discounting.

The following quotation from the "Green Book"** deserves comment at this point;

> "In most benefit-cost analysis, two basic assumptions are made: First, market prices correctly reflect social values. Therefore these prices are used to

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* While this approach clearly illustrates the theory involved in comparing costs and benefits over time, it is not the actual method normally employed in practice. A description of the actual methodology will be given later.

** Proposed Practices of Economic Analysis of River Basin Projects, is often referred to as the "Green Book" (see note 3).

> estimate benefits and costs. And secondly, the distribution of benefits among economic sectors and individuals does not enter into an economic feasibility study; i.e., projects are financed by government ... if the benefits to <u>whomever they may occur</u> are in excess of the estimated costs."(3)

Let us look at the first part of the above quotation, that is, the assumption that market prices correctly reflect social values. Market prices would indeed be a fair evaluation of social values if it were not for two facts. First of all there are market imperfections in our economy. The ideal state of pure or perfect competition does not exist in fact due to such things as oligopolies, monopolies, and government intervention. The important thing here is to recognize the existence of these market imperfections. This does not mean that the prices on the market even though imperfect do not have any reflection of social values; however in many cases it is necessary to adjust them or to at least be aware that they are not perfect. In other cases, we must derive the value of goods or services as if they were actually marketed even if they are not. For example, another government agency may supply certain services such as those of a consulting engineer, and yet not bill us for these services. Since we also count the beneficial effects that accrue to any other such agency it is only fair to also count any such costs.

Looking at the second part of the above quotation, we run into the problem that is brought about by large scale projects. Often,

the net effect to the entire economy will actually be zero; but there definitely will be a transfer or shifting of income between sectors or areas. Current benefit-cost practices do not take these factors into account. A difficulty arises therefore in meeting the variety of objectives of the government. If our goal was merely to add to gross national product or some other measure of production, then one need not be concerned about any such shifts of incomes. However, when such goals as regional development are introduced, factors such as the shifting of incomes grow in importance.

A few words on price projections. Prices will change over time for two fundamental reasons: inflation, and relative changes in costs. Ideally, one would forecast the price changes that would affect either the benefits or the costs. However, in current practice this is not done. Both costs and benefits are valued at the current price levels for the entire span of the economic life of the project or program. This is done because it is very difficult to forecast the multitude of price variations that could occur for all goods and services either consumed or produced by any given project or program over a period of 25 to 50 years. Price changes merely due to inflation are assumed to be constant for all the goods and services involved although this assumption is not always so. These price changes are taken into account by discounting which will be discussed in a later sub-section.

3(a) Primary Benefits and Costs

Primary costs or benefits are also known as direct costs or benefits. Primary or direct benefits are those benefits which accrue to the direct users of the goods and services provided by the project

or program. Primary or direct costs are those costs which are used to construct, operate and maintain the actual project or program. A related concept is that of associated costs. Associated costs are the costs which must be incurred by the direct beneficiaries of the project or program in order to utilize some or all of the value of the benefits of the project or program. An example of this would be the work that must be done on the property of each individual farmer to take advantage of an irrigation project for a certain area.

In evaluating primary benefits one should use market values where possible. If the market prices are not considered to be reasonable, usually because of imperfect market conditions, then one should use some other method such as estimating the cost of the next most likely alternative project in the absence of the project in question. Likewise primary costs will be based on market values where possible. Otherwise, some sort of estimate must be made. The associated costs can be treated in two ways: they can be subtracted from the primary benefits or they can be added to the primary costs. The advantage of the former method, supposedly, is that it isolates the public cost. Either method is acceptable as long as consistency is maintained.

Another concept that should be considered here is that of joint costs versus separable costs. This concept applies in the case of a multi-purpose or multi-objective project. Separable costs refer to those costs which can be attributed to one purpose or objective, while joint costs refer to those expenditures which cannot be classified as belonging to a single specific purpose or objective.

In most cases it will not be necessary to divide the joint costs and therefore they can be treated as an aggregate. Nevertheless, situations may arise where it is necessary to treat them individually such as when more than one agency is involved and the different agencies are concerned primarily with different purposes. An example would be a joint federal-provincial effort to build a large multi-purpose dam. In this case the normal method seems to be to apportion the joint costs in the same proportion as the expected benefits from each service provided by the project. Another way would be to apportion the joint costs equally amongst the various alternative purposes or objectives of the project. This is so dependent on the specific situation that any general rules would be difficult to formulate.

A note with respect to the separable costs is necessary herein. The separable costs corresponding to any single purpose or objective should not in any situation be greater than the benefits which accrued to that purpose or objective.* These separable costs are in fact a form of variable costs and if they cannot at least meet this simple test of economic feasibility then the money would be better spent elsewhere.

All sorts of adverse effects must be considered under primary costs. These adverse effects or damages must be counted as costs since the losses are suffered by the economy in some way, even though the agency responsible for the project may not be required to compensate the parties suffering the losses. The loss may take the form of a complete displacement of some sort of service or possibly the reduced productivity of some facility. For example, the construction of a power dam and the resulting reservoir created may cause considerable upstream land erosion

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* Unless one phase of the project has been implemented purely as a subsidy to aid regional economic development.

thus reducing the amount of effective arable land in use in that area. Again, a project involving the cutting down of timber may result in soil erosion which would in turn reduce the productivity of the affected farm lands. The number of situations of this type are endless and call for discretion and judgment by the analyst.

One item which is often neglected from the discussion of both benefits and costs is the matter of taxes. From the public point of view any increased cost of government services either in the form of extended services or greater cost for present services must be treated as a cost to the society or economy. Conversely, an increase in taxes collected must be regarded as a benefit to the society. Furthermore, when property is purchased for a project or program, any debts for public facilities that were to have been paid from the future property taxes must also be regarded as a cost. This could often happen when the federal government purchases developed land within a municipality.

3(b) Secondary Benefits and Costs

Secondary costs and benefits are also known as indirect costs or benefits. Secondary benefits are induced benefits. This simply means that they are benefits over and above those which prompted the project or program to be undertaken. Secondary costs are those costs which must be incurred in order to realize secondary benefits. One example of the secondary effects is in the case of an irrigation project, where the increased agricultural activity resulting from the project stimulates the fertilizer industry in the area. The extra income accruing to the industry would be the secondary benefits while the additional costs, such as those for plant expansion, would be the

secondary costs. The most traditional example would be in the case where the primary benefits involve an increase in the production of wheat. This would then have secondary effects with respect to the storing and milling of wheat, the baking of bread, and the transporting, warehousing and marketing of the bread.

The perspective of the analyst is of prime importance when considering secondary benefits. By this we mean: is it national or regional or local? At the national level most analysts feel that the secondary benefits tend to cancel one another out. They feel that a project's secondary benefits to the national economy would be the same regardless where the project is located and regardless of the type of project (assuming of course that it is of the same magnitude). From a regional point of view the analyst would definitely consider any secondary benefits as significant if the alternative was to locate the project outside the region or area in question. In other words a benefit cost analyst working for a provincial government is more likely to consider secondary benefits than an analyst working for the federal government. However, this is not always the case. An analyst at the national level may also be interested in regional development or balanced development through the economy, and if this were the case he would definitely consider secondary benefits. In the less general case where only a single alternative is being considered one might make a case for secondary benefits, under the assumption that the resources would otherwise remain idle.

This brings us to the question of full employment in the economy. The arguments in the above paragraph assume full employment - a common assumption in benefit-cost analysis. Under this assumption

it is quite correct to say that there cannot be any secondary benefits from a national point of view; but there can be a transfer of these secondary benefits from one sector of the country to another. However, since full employment of resources is an ideal state and seldom achieved in practice, it follows that any use of resources that would otherwise be unemployed does constitute a national benefit and hence, at least in theory, such benefits should be included as secondary benefits. To go further, if some of the resources are presently employed but by means of the project or program are more profitably employed, then this increase in productivity is also a secondary benefit of the project or program in question. The difficulty in practice is that the techniques used to measure the effect of secondary benefits on unemployment or on the underemployment of resources are limited.

There are other common assumptions about secondary costs and benefits. One is the idea that secondary costs equal secondary benefits. This is a rather dubious assumption. Another assumption often made, usually because of a lack of data, is that there is a proportional relationship between secondary and primary net benefits resulting from a project or program. This latter assumption may occasionally be justified, especially when the projects being compared are of similar type and magnitude; but it is still more of a hypothesis than a validated theory.

When secondary effects are being considered, they should be treated separately from the primary effects. This is because such data as is available for secondary cost benefits is usually less exact, i.e., it is not as readily quantifiable as that for primary benefits and costs.

Secondary benefits are much more easily handled in theory than in practice as some of the difficulties just mentioned have shown. Another difficulty in dealing with secondary benefits is that it is rather difficult to know where to stop. One could theoretically stretch the search for secondary benefits almost indefinitely through the dimensions of space* and time**; but the accuracy and the meaning would soon be lost.

3(c) Discounting

There are two major difficulties in measuring tangible costs and benefits. First, they do not all accrue at any single moment in time; and second, the benefits do not occur with 100% certainty. Thus to allow any meaningful comparison of benefits and costs during the economic life of a project or program one must make allowances for the time disparities and for the risks and uncertainties involved. To allow for the time differences, one must modify the costs and benefits so that they can be compared at a single point in time. The most common method is to convert them to their present value. The discount rate is a percentage figure used in making this conversion. Factors of risk and uncertainty may be included in this discount rate.

The temporal disparities involved are based on a concept known in economics as time preference. This in turn relies on the observed fact that most people prefer present consumption to future

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* any geographic area could eventually be considered.

** a 35 to 50 year time period could be considered reasonable.

consumption. People will only defer present spending if there is some sort of additional compensation to be achieved in so deferring consumption. This means that even if there was no risk involved at all in the project benefits one must still make allowance for the various temporal differences occurring in the measurement of benefits and costs. However, the time preference concept is usually not separated from the risk concepts except in theory. A number of uncertainties can be accounted for by means of the discount rate.

One such form of uncertainty arises from the changing value of money. Since money is the normal common denominator for measuring tangible costs and benefits it is most important that this be allowed for. Because it applies to both costs and benefits and changes in a somewhat constant manner over relatively long periods of time, it can be dealt with in the discount rate. In other words, the discount rate, besides reflecting time preference also reflects the inflationary trends of the economy.

Time itself is a risk factor. That is, the more distant the benefits timewise the more uncertain they are. This also may be reflected in the form of a risk premium in a discount rate. It is most appropriate when the uncertainty involved is strictly a compounding function of time. This might be used when dealing with long-term projects about which there is no information regarding the risk; all that would be known is that a considerable length of time is involved before the final benefits are realized. Another way to allow for the risks generated by a long project life would be to shorten

the period of analysis. This method, however, tends to penalize those projects with a relatively longer economic life and/or which are capital intensive.

If it is felt that the risks are not correlated with the passage of time, one can account for them somewhat by introducing a safety allowance. This is basically a process of making conservative estimates to the benefit side of the picture.

Another method that is often used by benefit-cost analysts is sensitivity analysis. This is usually done by first using a median discount rate (e.g. 7%) and finding the benefit-cost ratio. Then the discount rate is varied above and below this median figure to see the effect of various discount rates and hence various levels of risk on the benefit-cost ratio. (see Table 1). This gives the decision maker a range of values rather than a single figure upon which to base his decision.

Table 1

	Years						
	0	1	2	3	4	5	
Benefits ($)	0	35	50	100	100	100	= $385.00
Costs ($)	185	50	10	10	10	10	= $275.00

Discount rate = 0% Benefit-cost ratio - $\frac{\$385.00}{\$275.00}$ = 1.40

Discount rate = 2% Benefit-cost ratio - $\frac{\$359.00}{\$271.20}$ = 1.32*

Discount rate = 7% Benefit-cost ratio - $\frac{\$300.60}{\$262.50}$ = 1.14

Discount rate = 12% Benefit-cost ratio - $\frac{\$249.30}{\$254.80}$ = 0.97

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* This ratio is derived as follows

- the benefits in each year are discounted by 2% for every year in existence.

  e.g. year 2: $50 X .98 (year 1) X .98 (year 2) = $48.20

  e.g. year 4: $100 X. 98 (year 1) X .98 (year 2) X .98 (year 3) X .98 (year 4) = $92.24

- next the discounted benefits are added together to total $359.00

- the same procedure applies to each cost. The total of the discounted costs = $271.20

- the new benefit-cost ratio = $\frac{\$359.0}{\$271.2}$ = 1.32

Note that the first example in Table 1 gives the benefits and the costs for a single project with no discounting allowance and thus a benefit-cost ratio of 1.40. The high discount rate (12%) shows the conservative side of the picture and gives the decision maker an idea of what will happen if the risks are high or if things tend to go badly for some otherwise unforeseen reason. The low discount rate (2%) in turn shows the optimistic side of the picture on the assumption that everything will go well.

One can carry the sensitivity analysis even further by considering several projects and showing that the first ranking project has the best benefit-cost ratio for all the discount rates chosen or that at some critical point (a particular discount rate) a second project assumes the best benefit-cost ratio. This often happens when a variety of discount rates are used. In such a case the analyst must inform the decision maker at which point this critical discount rate occurs. Decision theorists have developed other methods such as decision trees for assessing the impacts of risks and uncertainties. These, however, go beyond the scope of this paper.

Now a look at how the discount rate is normally chosen. The Federal Government has two means of obtaining money. One is through taxation and the other is through borrowing. Either method of obtaining revenue draws these funds from the private sector of the economy. Thus using the "opportunity cost" principle we merely have to look at the interest rate that private borrowers pay to obtain funds. This interest rate then tells us the cost of these funds of which we are depriving the

private sector of the economy. In the private sector the interest rate includes a premium for the risk associated with the possibility that a company may default in its payment. There is no equivalent risk for the Federal Government. That is, the Federal Government can never go bankrupt. Thus we must look for an interest rate that does not include the risk premium for private companies. For this purpose most benefit-cost analysts use the average return on long-term Federal Government bonds. These bonds must compete with the bonds of private industry, with the only advantage being that they are risk free. Thus the return that they yield must be the same as that of private industry bonds minus the risk premium due to the possibility of default of payment by a private company. For the sensitivity analysis most benefit-cost analysts choose a range based on percentage points such as 2% or 5% above and below the median discount rate. Thus if the long-term Canada bonds are yielding 7% on average the analyst will also compute the benefit-cost ratio at 5% and 9% or at 2% and 12%. Should the ranking of projects remain the same regardless of the discount rate chosen, then the analyst will conclude that the ranking of the project is not sensitive to the discount rate chosen and thus there is no need to make any allowances for risk in the selection of the project by the decision maker. Should the ranking of the projects be found to be sensitive to the discount rate chosen, then the analyst should also specify the critical or breakeven point which was discussed earlier. This point is significant because the choice of a discount rate may be a policy matter (e.g. to favour long-term durable projects such as dams).

There are several points to consider when using discount rates. A low discount rate will favour more durable and more capital intensive projects. This may lead to the justification of projects which have little economic value. Furthermore, the durable and/or capital intensive projects are very sensitive to small changes in the discount rate. To decrease the project life would be equivalent to raising the discount rate since benefits which would accrue beyond this point are discounted completely. One must also bear in mind that the discount rate could quite conceivably change over the economic life of the project, i.e., time preferences themselves can change over time. The methods that have been discussed in this section, except for sensitivity analysis, do not reflect this fact. This then is another assumption, like the assumption of constant prices throughout the economic life of a project or program, that decision makers should be aware of when studying the final report of a benefit-cost analyst.

3(d) Intangible Benefits and Costs

Up to now we have been dealing with tangible effects. While practical measurements of these tangible effects may be very difficult, the theoretical basis for them is relatively simple. However, when we come to intangible benefits and costs we enter into an entirely different world. The practical methodologies involved here are highly simplistic whilst the theoretical considerations are extremely complex and involve disciplines such as philosophy, political science, and sociology.

Intangible benefits and costs are all those effects which are not readily quantifiable in terms of money values, that is to say, for practical purposes they do not have a market value. This complicates the

analyst's job because market prices are the only common denominator which has any wide application in measuring social values (no matter how far from the ideal this might be). Some examples of intangibles which can be either primary or secondary effects are: balanced regional development, national defence, the preservation of life, the preservation of democracy, conservation, and social stability.

Since benefit-cost analysis is a technique primarily designed to deal with quantifiable benefits it follows that intangible effects should be quantified whenever possible. Many so called intangibles can actually be subjected to quantitative measurement. However the unit of measurement differs from the common denominator, i.e., market value. One can of course use various methods to simulate market values for just about anything; however, these figures can be disputed. Furthermore, when one does simulate money values for "an intangible" one must, as in the case of secondary tangible benefits, not put this figure into the primary benefit-cost ratio. This is essential because the accuracy is usually of a less precise nature.

In dealing with intangible costs and benefits the most widely used procedure is similar to that often used for secondary tangible benefits, that is, to ignore them completely, based of course on some sort of rationalization. However, intangible effects are often too important to neglect, in fact they may be even more important than the tangible considerations. One accepted method of dealing with intangibles is to describe them verbally, possibly dividing them into positives or negatives based on a qualitative accessment. Another commonly used method is the expenses method. For example, if one wanted to measure

the intangible recreational benefits of developing a reservoir or lake, one could equate these with the anticipated or forecasted increase in expenditures for such items as accommodations, food, etc. Still another method would be to estimate user charges that could hypothetically be charged or one could question the users of the facility to find out what it is worth to them, say on a daily or weekly basis. One could also look at the next closest equivalent facility and estimate the extra cost involved in travelling to and from this alternative facility.(4)

Another method of treating intangibles involves computing the benefit-cost ratio for the tangible benefits and costs, and giving an implied dollar value to the project's set of intangibles. For example, let us suppose that the analyst is considering two alternatives, Alternative A and Alternative B. Let us further assume that Alternative A yields the higher benefit cost ratio, say 2:1, with Alternative B being 1:1. Now it becomes obvious if one were to choose Alternative B over Alternative A then one is implicitly valuing the net intangible benefits for Alternative B as being equal to or greater than the tangible benefits for Alternative B since the total implied benefit cost ratio for Alternative B would have to be at least 2:1 in order to choose Alternative B over Alternative A. This means if the total tangible benefits for Alternative B equaled $100,000 then the net intangible benefits would be at least equal to $100,000 and probably greater. There is one major complication to this method and this is brought out very well by Roland N. McKean:

> ---if the alternative use of the resources also involves significant intangibles, not much can

> be said. The situation would then be like that in which the little boy valued his puppy at $50,000 and, according to his story sold it for that amount. How? By accepting a couple of $25,000 cats as payment.(5)

There are various other ways of quantifying so called intangible benefits either in whole or in part. However, all of these methods have one basic requirement that is usually not fulfilled: they depend on very clearly stated detailed objectives* which must be known to the analyst. Then and only then can the analyst proceed to use methods such as a decision matrix.

One of the major difficulties when dealing with intangible effects is the selection of the appropriate objectives and targets. This is a very difficult problem especially with regard to the source of criteria for the setting of a hierarchy of goals. The question arises: should one use professionals or career civil servants, or some special committee of politicians or public opinion polls? The other difficulty that arises is what to do about the relative weights that must be assigned to each objective or target. This is especially complicated when the economic goals, such as those set by the Economic Council of Canada, are expressed primarily in monetary (market) terms and the other goals are expressed either in subjective, descriptive terms such as "uniqueness" or as some general form of utility which is left vague and unspecified.

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* It is extremely difficult to communicate precisely what are normally considered to be non-measurable objectives.

4. Evaluation

Once the socio-economic data is collected as described in the previous section, the next step is to evaluate the data. In the flow chart this stage is represented by the computation of two types of benefit-cost ratios since the B/C ratio is the most commonly used method of evaluation at present. It is, however, by no means the only technique available. Other techniques to be discussed include internal rate of return, net benefits, minimum costs, maximum benefits. Optimization of Scale and Sensitivity Analysis are two subordinate techniques which are often used in conjunction with the others. The technique used in evaluation is related to a great extent to the purpose of the analysis.

The techniques discussed below relate (as shown by the flow chart) only to tangible data except for a very brief final sub-section on intangible data.

4(a) Benefit-Cost Ratio

The first technique to be considered is that of the benefit-cost ratio. As stated earlier, this is the most commonly used method of evaluation. There is good reason for it being number one: of all the techniques currently used, it is the most reliable.

With respect to purpose number one, the ratio is a quick, simple means of assessing economic feasibility. If the ratio is 1:1 or greater then the project or program is "feasible" economically. This is the minimum requirement for efficiency and "efficiency" is the key word, for the B/C ratio is simply a measure of economic efficiency. The ratio is also very good for the ranking of alternative projects

in terms of their economic efficiency. This ensures, without complicated manoeuvres, that the costs are in line with benefits, at the same time as the ranking is determined. Therefore, the higher the ratio, the more efficient the project and, therefore, the higher the rank.

One can compute the primary benefit-cost ratio or the total benefit-cost ratio or both. The primary ratio consists of all primary tangible benefits divided by all primary tangible costs, all appropriately discounted. Hence

$$\text{Primary B/C ratio} = \frac{B^1}{C^1}$$

The total ratio consists of all the elements of the primary ratio plus the secondary tangible benefits divided by the secondary tangible costs. Hence,

$$\text{Total B/C ratio} = \frac{B^1 + B^2}{C^1 + C^2}$$

In theory it would seem that the total ratio is more important than the primary ratio since the federal government is interested in maximizing benefits and minimizing their costs everywhere in the economy, regardless of their incidence. However, there is the problem of accuracy to contend with. Primary effects can be measured much more accurately and completely than secondary effects. Thus the primary benefit-cost ratio is a more accurate figure (although more limited in content) than the total ratio. Furthermore, as mentioned earlier in this paper, secondary effects are often "excused away" and thus not considered

in practice; this would obviously limit the analysis to the primary benefit-cost ratio.

When it is possible to compute both of the above ratios, both should be presented to the decision maker. If the two ratios are in accord with each other, i.e., the two yield the same conclusion, then they add more certainty to the analysis. If they are not in accord with each other, then a possible weakness in the analysis is brought to everyone's attention (although this does not necessarily imply that the analyst is at fault). In this latter case the analyst should attempt to interpret the discrepancy, i.e, is the discrepancy due to a very sketchy knowledge of secondary effects? or is there actually a difference between the alternative projects with respect to the proportion of secondary (primary) benefits to secondary (primary) costs?

R.J. Hammond offers vigorous opposition to the concept of a "total benefit-cost ratio":

> "There are ---- good reasons why secondary benefits should never be lumped into a single benefit-cost ratio along with primary benefits and costs. In the first place, there is no satisfactory way of doing it. If one follows the practice of some agencies and adds in only the net secondary benefits i.e., secondary benefits <u>minus</u> secondary costs, one obscures the fact that the secondary benefits cannot arise unless additional extra project costs are incurred, and thereby unjustifiably improves the benefit-cost ratio. If, on the other hand, one adds

in costs on one side and benefits on the other, this obscures the picture on the costs side, by making it appear that all of them must be incurred, and may distort the ratio in either direction ---- Secondly, presumably no one would ever overtly undertake a project for the sake of the secondary benefits, or for that matter of the imponderables, so that it is illogical to include them in a primary project justification."(6)

The significance of the distinction made earlier between a project and a program will be explained now. When alternative programs are being considered, it is important to ensure that each component project has a benefit-cost ratio equal to or greater than one. If not, then the project with a benefit-cost ratio less than one would have to be justified by the intangible effects attributed to that project. Should the project be necessary for the attainment of one of the other projects in the program (concept of derived benefits) then the two projects should be considered together and are justified only if their combined benefit-cost ratio is equal to or greater than one.

4(b) Internal Rate of Return

This is a technique for evaluation that is not in much use. However, some economists are forever advocating its use and thus it merits discussion in this paper.

Its main advantage, supposedly, is the fact that the analyst does not have to select an arbitrary discount rate (in order to convert future benefits into their present value). This is fine as long as all costs are incurred at the start of the project - that is, as long

as there are no operation and maintenance costs. If there are future costs to contend with, then these must be reduced to present value and the "advantage" of the internal rate of return (IRR) is lost. Furthermore, this "advantage" is lost again if one wants to test for economic feasibility (and most rational people do), since one must compare the IRR or yield to something. This something is the cost of capital (which is usually what is used as the discount rate).

Added to the above are two disadvantages. First of all, it is both difficult and cumbersome to compute. Assuming that all costs are incurred at the start, one must by trial and error find an interest rate such that the benefits will have a present value equal to the costs, or in other words, such that the net benefits are zero. This first difficulty can be overcome, however, through the use of computers. The second difficulty is not so easily resolved and the use of a computer may only make matters worse. The problem here is not for the analyst but for the decision maker who must use the results of the analysis. If he (the decision maker) is to use such results intelligently, he must have a clear conceptual understanding of how the results were derived and the corresponding significance thereof. Otherwise it will be difficult to know which comparisons are appropriate. He could of course rely on the analyst (and his faithful computer), but in this case he would be a "rubber stamp" and not a decision maker.

Now let us consider for which of the two uses the IRR method is appropriate. From the second paragraph of this sub-section it is quite clearly implied that the IRR only fulfills purpose number two; i.e., to assist in ranking alternative projects or programs. But

even here it is limited, since its "advantage" only applies when all costs are incurred at the start.

For those who want to go into this controversy of "present-value" techniques versus the "internal rate of return" (also known as the Yield of an Investment Method) the book The Capital Budgeting Decision by Bierman and Smidt(7) is recommended.

4(c) Net Benefits

This is a method utilizing the present value concept in the same manner as the benefit-cost ratio. Also, like the ratio, it is frequently used in the evaluation stage of benefit-cost analyses. It involves subtracting rather than dividing. One merely subtracts the costs from the benefits.

The net benefits technique may be used for both purposes of benefit-cost analyses. Judging economic feasibility is done in a manner similar to that employed by the ratio method. A result of "zero" or better indicates that the project has met the minimum criterion of economic feasibility. Ranking is done by placing the project or program with the greatest net benefits first, and so on.

The net benefits method is most appropriate to the single purpose agency, such as an electric power corporation. In other words, this method is most appropriate to a public agency which resembles a private corporation (assuming that the only objective of the private corporation is to maximize "profits").

This concept can be best shown by means of a simple numerical example as presented below in Table II. In this example it is assumed that the five alternative projects are mutually exclusive, that is, only

one of the five projects can be undertaken - there is no way of choosing a combination of two or three of the projects.

TABLE II

Project	Costs(C^1)	Benefits(B^1)	Net Benefits(B^1-C^1)	B/C Ratio(B^1/C^1)
A	$10,000	$15,000	$5,000	1.5
B	$20,000	$25,000	$5,000	1.25
C	$30,000	$33,000	$3,000	1.1
D	$ 5,000	$ 7,000	$2,000	1.4
E	$70,000	$76,000	$6,000	1.09

Looking at projects A and B we can readily grasp one of the biggest faults with the net benefit approach and that is its inability to distinguish between two alternative projects when the net benefits are identical but the costs differ. The ratio method, since it is a measure of relative efficiency, makes the appropriate distinction. This distinction becomes insignificant only under the implausible conditions where there is no budget constraint and no alternative use for the extra resources being consumed.

An even more interesting fact comes to light when we examine projects C and D. According to the net benefits approach, project C is preferable to project D because C yields $3,000 in benefits compared to $2,000 from D. The ratio method gives the opposite ranking and one can see that the rational decision here would normally be to choose D over C. Going back to our single purpose agency, however, one has

to admit that if one looks at the problem strictly within the terms of reference of the agency in question, the net benefit approach gives the correct answer.

However, if one considers such a decision in the context of a multi-purpose agency (or in terms of the totality of federal government agencies) then it would appear reasonable to assume that the additional $25,000 in costs needed for project C relative to D could somehow, somewhere yield at least a net benefit of $1,000 and probably more. Hence, using the benefit-cost ratio would appear to be more in order in this case.

Project E was put into the table to show why a careful understanding of the two evaluation methods (net benefits and ratio) is necessary. In this case, depending on the evaluation technique used, project E could be ranked "first" or "last". It also shows why the decision maker should have a basic knowledge of what the analyst is doing and not just accept without question a column of numbers, either of net benefits or ratios.

The discussion of the net benefits approach so far has tended to put this technique in a bad light. However, it can be shown that when making subjective decisions regarding the relative merits of intangible versus tangible effects, the net benefits method is clearly superior.*

4(d) Minimum Cost

The minimum cost method, while recognized as an evaluation method, is not always considered to be a part of "benefit-cost analysis" proper. However, the benefit-cost analyst is sometimes required to use it. Thus, there is no point in branching off into an argument on

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* Our next paper will cover this subject in detail.

whether it should be considered as a completely separate technique or not.

This technique of evaluation is made necessary when the benefits are fixed.* The implication here is that the decision maker knows exactly what he should achieve. The analyst then has no choice but to carry out the procedure for a benefit-cost analysis solely on the cost side. When he (the analyst) gets to the evaluation stage he has a list of projects or programs and their corresponding costs. Each project which remains is already judged feasible, since feasible in this situation means that it meets the minimum requirements with respect to the objectives set by the decision maker. The only thing left to do is to rank the alternatives on the basis of cost.

This is done quite simply by choosing the alternative with the lowest cost to be the first ranked. The fact that another project costing slightly more yields many times the benefits is irrelevent in this context.**

4(e) Maximum Benefits

The maximum benefit approach is the reverse of the minimum cost method. In this situation the cost is fixed and the analyst only looks at the benefit side. When he reaches the evaluation stage he has a list of projects and programs all costing the same (or less than the budgetary limit). Unlike the budgetary constraint referred to earlier in this paper, the constraint is imposed on a single project

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* Usually they are also of a primarily intangible nature.

** The analyst, should he find such a wonderful project exists, would, we would hope anyway, bring this fact to the attention of the decision maker who might reconsider.

or program rather than on the agency as a whole. In such a case the analyst merely compares the benefits that accrue to each project and chooses the one which has the most benefits. This may not be as easy as it seems, since benefits in a case like this are often of an intangible nature and possibly not at all homogeneous.

4(f) Optimization of Scale

We are now at the stage where the analyst has narrowed down the alternatives to a single "optimum" project.* His work is not necessarily finished. Often, such as in the case of an electric power dam, one has a variety of what one might call "internal choices". In other words the analyst, having chosen the optimum project, must now select the optimum size or scale of that project.

The criterion employed is that of "maximum net benefits". If the ratio method has been used for selecting the project, there are two possible ways of determining the optimum scale. One of these methods is to increase the scale of the project to the point where the marginal B/C ratio is equal to one, that is, where $B^1/C^1 = 1$.** After this point any further expenditure would yield additional benefits in an amount less than the further cost (although total benefits may still exceed total costs until an even larger scale is reached). The Guide(10) also presents another method. It states: "In order to optimize

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* The selection may have been narrowed down to a set of projects instead of just one, unless the alternatives are mutually exclusive or the budget constraint will only permit the one.

** The theory behind this is covered in both "The Guide" (see note 8) and the "Green Book" (see note 9), complete with the relevant graphs.

the first-added project, its scale must be increased to the point where its benefit-cost ratio is above, but only just above, that of its next best alternative.(11)" This means that if the second ranked project has a benefit-cost ratio of 3:1 then the first ranked project should be increased as far as possible subject to the constraint that B^1/C^1 does not fall lower than 3:1. This latter method is clearly superior in that it insures (within the range of alternatives proposed) that economic effectiveness is maximized.

If the ranking was based on the net benefit criteria then the only way to optimize the scale of the project would seem to be to increase the scale until the incremental benefits equal the incremental costs (similar to the former method mentioned above).

In all of the above methods of optimizing scale it must be remembered that projects are not usually subject to infinitesimal decisions. It would therefore be wise to get technical advice on the scales that are possible before a "paper Utopia" is devised.

4(g) Sensitivity Analysis

Sensitivity analysis, described previously (sub-section 3c), is a secondary or subordinate technique. It can be used with all the major techniques, except for IRR, in the manner described. Sensitivity analysis can also be used for other uncertain areas such as economic life or relative price changes.

4(h) Evaluation of Intangible Effects

This topic, for the purposes of this paper, has been covered very generally in sub-section 3(d), "Intangible Benefits and Costs" and thus need not be repeated here. However, this sub-section is inserted

because we have now reached the point (based on the flow chart) where the intangible inputs are to be evaluated. As implied earlier, the current methods for such evaluation are not considered satisfactory except for a limited number of situations.*

5. THE COST OF A BENEFIT-COST ANALYSIS

A few words should be added concerning the cost of a benefit-cost analysis itself. This is often a difficult problem because the benefits from different projects are usually variable while the cost of the analysis is usually fixed according to the size of the project. Some analysts suggest that after the technical feasibility studies have been made, five per cent of the anticipated benefits of the project should be spent on the benefit-cost analysis itself. This, of course, raises the problem of how much the anticipated benefits might be. If one knew this with any great degree of accuracy then there would be no need to have any further benefit-cost analysis, at least, not on the benefit side. What if you do not have a definite idea of the magnitude of the benefits to be received? And even if you do, the important factor to ascertain here are the net benefits, not the total benefits. Thus a knowledge of the magnitude of the costs is implied. But when the analyst knows generally what the expected benefits and costs will be, then it is rather late to start budgeting for his analysis, since he is well into it by this time. What is probably readily predictable is the maximum direct tangible gross benefits. However, to take into account all benefits, be they direct or indirect, tangible or intangible,

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* Our next paper will present a general methodology for evaluating intangibles within the context of a benefit-cost analysis.

and to study the uncertainties involved to get either a range of possible benefits or a statistical probability for expected benefits, requires much research. Since benefit-cost analysis involves fixed costs more than variable costs, it would be more practical to specify an amount, such as $100,000, as a cutoff point. Any project costing $100,000 or more would then be carried out only after a benefit-cost study has been made. Projects of lower cost magnitude would be analyzed with less involved techniques.

6. FINAL NOTE

There remains one last aspect to be discussed. As stated at the beginning, this paper has presented a generalization of the benefit-cost process. This has necessitated quite a bit of distortion. In order to present the basic techniques and concepts (the HOW) it was necessary to be somewhat free with the WHO and the WHEN of the process.

Looking first at who would be involved in such a study, it would seem from this paper that there are only two persons: a decision maker and an analyst. Such a situation would be rare indeed. Usually the "decision maker" comprises a whole hierarchy of people. In addition, at any particular level in this hierarchy, the decision maker is more apt to be some sort of board or committee (especially at the higher levels) rather than a single individual. For example, let us look at the setup for a joint federal-provincial comprehensive river basin plan under the Canada Water Act: In this case the first level of decision maker would probably be the study director, then the federal-provincial river basin board or committee, then the federal-

provincial consultative committee or board for the province. After this, the chain of command becomes less clear. The consultative committee theoretically reports to the federal minister responsible for the C.W.A. and his provincial counterpart. However, the report would normally be filtered through various public servants at several levels before actually and effectively reaching the minister in question. On the federal side this would include officials in the departmental hierarchy plus the Interdepartmental Committee on Water. Eventually after the minister receives it, it would go to a cabinet committee and finally to the cabinet (the Governor-General-in-Council). All of these people and committees are included in the term "decision maker".

Then we have the "planner". He was not even mentioned in the paper until now. This is because we have presupposed a case so simple that the analyst did all the necessary tasks himself, except determining the objectives, regardless of whether they were strictly and solely part of the benefit-cost analysis itself. This brings up a need to distinguish between planning and benefit-cost analysis. Since this is not really within the scope of this paper, let us simply remark that the analysis is a <u>part</u> of the planning process. Such things as postulating alternative solutions and collecting data, while necessary for a benefit-cost analysis, are not essential components of the analysis in its strictest sense.*

It is possible for decision makers to also be planners (usually at the more operational end of the hierarchy) such as in the case of

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* In its strictest sense, benefit-cost analysis might consist almost solely of the evaluation stage which would put the analyst in a relatively minor role, which is not normally the case.

river basin boards under the Canada Water Act. Furthermore the analysts are likely to be planners or at least some of the planning staff will be analysts.

The WHEN presents a similar problem. The flow diagram shows each activity taking place in a definite sequence. Actually, it is rather unlikely that any such sequence would ever be followed. To postulate alternatives without any socio-economic data would be ridiculous. (However, the detailed facts would usually come after the alternative projects have been specified). Knowing the benefits and costs in a general sense is also important when suggesting alternatives. Furthermore it was mentioned in the previous section of this paper that a general idea of the net benefits was needed before the analysis was even started.

Thus this paper has presented only the concept and methods of benefit-cost analysis in a fairly rigorous manner. The WHO and the WHEN, as presented in this paper, must be viewed merely as generalizations, as a means to facilitate an understanding of the methodology involved.

Notes

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2. Prest, A.R. and Turvey, R., "Cost-Benefit Analysis: A Survey," The Economic Journal, Vol. LXXV, December, 1965, p. 685.

3. Report to the Inter-Agency Committee on Water Resources by the Sub-Committee on Evaluations Standards, Proposed Practices of Economic Analysis of River Basin Projects, Washington, D.C. 1958, p. 10.

4. For a detailed account of the last four methods mentioned, see Spargo, R.A., Evaluation of Sport Fisheries: An Experiment in Methods, Environment Canada, Ottawa. 1971.

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9. Proposed Practices for Economic Analysis of River Basin Projects, op. cit., pp. 12-14.

10. Guide to Benefit-Cost Analysis, op. cit. p. 9.

11. Ibid.

A Simplified Flow Chart of a Benefit-Cost Analysis