Chapter 4

Benefits and Costs, Winners and Losers

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I. INTRODUCTION

Should a project that will generate the equivalent of $9.5 million per year in net benefits necessarily be undertaken? Must a person who opposes such a project be regarded as in muddle-headed opposition to a rigorous chain of argument from universally accepted first principles and obvious facts? Must we regard the opening up of rural regions to commercial development as a good thing in spite of the apparent loss of amenity? The answer to all these questions is no.

Is economic analysis fundamentally incompatible with a regard for such intangible values as the complexity and variety of a free-running river? Must refined sensitivity be suppressed to permit the crass calculus of dollar gains and losses to proceed? Is the Tocks Island Dam decision a choice between "economic values" and other, higher values? The answer to these questions is also no.

The term "benefit-cost analysis" refers to an ideal procedure for resource allocation and to its embodiment in practice as a management tool. Theory and practice go back at least to 1844, when Jules Dupuit made his contribution to improving bridge investment decisions in France. However, relatively little development of them took place until the 1930s, when the United States government officially adopted benefit-cost analysis in water resource investment choices. Although this policy has remained in effect since then, and the area of application has been extended as the techniques of analysis have been refined and improved, there remains widespread misunder-

standing about what one validly can and cannot expect of it. This is our subject in this essay.

Below, in Part II, we introduce benefit-cost analysis by discussing the procedures the Corps of Engineers has actually used to evaluate the costs and benefits of the Tocks Island Dam project in the formal reports it has submitted annually to Congress. Much of what goes on, the reader will learn, is narrowly circumscribed by federal guidelines, and still other inflexibility is a product of the bureaucratic context within which these analyses are developed. If we are successful, the reader will have grown anxious about the outer limits of benefit-cost analysis that persist even after all such institutional constraints are removed and an analyst can do whatever he or she likes. The remainder of this essay addresses several of these limits.[a]

II. CALCULATING BENEFITS AND COSTS IN THE TOCKS PROJECT

1. The WRC Guidelines

The *Federal Register*[1] presents a set of principles and standards to be applied by federal agencies in the planning of federal water resource projects. These principles provide the guidelines for the benefit-cost calculations that must accompany any plan for water resource projects submitted by federal agencies to Congress for authorization and appropriations. The most recent principles and standards were developed by the federal Water Resources Council (WRC) and ultimately were amended and approved by Congress. The WRC is an independent executive agency formed in 1965 and responsible for coordinating water resource planning and development in the United States. It is composed of Secretaries of Interior; Agriculture; Army; Health, Education, and Welfare; Transportation; and the chairman of the Federal Power Commission; and it includes also participation of several other executive agencies, including the Environmental Protection Agency and the Council on Environmental Quality.

The principles and standards define the guidelines by which federal agencies are to develop a stylized balance sheet of project benefits and costs. Although the agencies are directed to list intangible factors not readily monetizable, the heart of the analysis is the display of benefits and costs measured in dollar units. The ensuing ratio of benefits and costs (the B/C ratio) is intended to play a twofold role. It should first form a loose guide both to the federal agencies and to

[a]The reader who is not especially interested in the Tocks case may wish to skim Part II of this essay.

Congress as to the priorities of projects, and second, play the role of a filter.[b] Projects with a B/C ratio less than one will not be considered for authorization. The guidelines imposed by Congress, therefore, may be seen as a way of limiting the number of projects with which Congress must contend, but not so much that Congress loses discretion over which projects to fund. In this sense the guidelines represent a compromise: there should be a filter but one not too fine. In this screening process, seldom if ever does Congress inquire into the basis of a benefit-cost evaluation, faulty though it might be. Rather, it has used benefit-cost analysis as a tool for controlling the bureaucracy, for imposing at least some modest amount of discipline on a set of agencies it otherwise has great difficulty controlling. The filter role for the B/C ratio is far more significant than its use in setting priorities. By all accounts, so long as the B/C ratio is above one, and "comfortably" so, Congress pays relatively little attention to it.

The Tocks project was planned and authorized under guidelines formulated by Congress in the late 1950s. These guidelines specified planning parameters, such as the discount rate to be applied to water projects (3 1/8 percent) and the average recreation value to be attributed to swimming, hunting, hiking, etc., which now seem out of date. And indeed, after a very substantial review, the WRC formulated a new set of guidelines in September 1973 that adduced several significant changes, among them the establishment of a discount rate consistent with the average cost of federal borrowing (6 7/8 percent),[c] an escalation of recreation benefits, and the establishment of a dual bookkeeping system in which planners must display *two* alternative plans—one maximizing "national economic development" (the old method) and one maximizing "environmental quality." This last change in practice permits consideration of a project with B/C ratio less than one if the reason is that a penalty has been paid for enhancement of environmental quality. Although it has been under

[b]Note that the *difference* between benefits and costs is more important and more meaningful than the B/C *ratio* itself since the ratio is affected by the somewhat arbitrary decision of whether to count factors as benefits or negative costs. Consider, for example, a project undertaken in a depressed area with an abundance of unemployed labor and resources. Here the utilization of these unemployed resources can with logic either be considered a net benefit or a negative cost, that is, a factor that will reduce the net costs of the project. To limit the discretion of the federal agencies undertaking the analysis, the principles and standards require in this case that the factor be considered a benefit—a conservative stipulation that minimizes the benefit-cost ratio.

[c]Congress afterwards established the discount rate at 5 5/8 percent to be applied to projects evaluated after March 1974. However, with this one exception the WRC principles and standards as published remain in effect.

almost continual review, the Tocks project has so far remained subject to a sort of grandfather clause: the earlier guidelines operable at the time of the project authorization are taken to apply.

In assessing the benefit-cost analysis of the Tocks project it is important to note the degree to which the guidelines—of whatever vintage—limit the discretion of the Corps of Engineers and other federal agencies in the calculation of benefits and costs. In several crucial respects, such as the choice of discount rate where the benefit-cost calculation may be subjected to criticism, the choice of assumption has been outside the Corps' control.

2. The Tocks Project: Summary Data

Summary of the Formal Calculation. As described in the preceding essays, the Tocks project is multipurpose, designed to provide recreation, water, power, and flood control. The recreation is provided by a national recreation area, centered about the reservoir and to be constructed in stages over several years. The recreation benefits will thus grow gradually as the recreation area is completed. The other three benefits will remain roughly constant over the entire life of the project. On the cost side, most of the project expenses will be incurred before and during the period in which the dam and reservoir are constructed. The most recent formal calculations of the project benefits and costs by the Corps are summarized in Table 4-1.

The assumptions that underlie these numbers have recently been clearly set forth by the Corps. Until 1974 these assumptions had, remarkably, never been made publicly available. For the first time in

Table 4–1. Summary Benefit-Cost Calculation for Tocks Project

Average Annual Benefits (millions of dollars)	
Recreation	11.7
Power	3.2
Water supply	10.2
Flood reduction	3.8
Total	29.0
Average Annual Costs (millions of dollars)	
Associated with the initial construction and recreation	15.9
Associated with future recreation	2.4
Total	18.3

Note: These calculations are based on a discount rate of 3-1/8 percent and a project life of 100 years.

the history of the Tocks project, it is possible for outsiders to replicate with confidence the benefit-cost calculations. This is done below, with the more technical aspects of the calculation put into boxes offset in the text. The reader can safely skip these technical excursions, though we hope some will want to work through the calculations—a fine way to dispel any lingering mystery they may hold. The two elements of Table 4–1 that may be unfamiliar to some readers are the discount rate and the concept of average annuities.

Discount Rate. The discount rate, which is discussed more fully in section IV, measures the rate of exchange between dollars in one period (today) and dollars at a later period. To say that a group uses a 3 1/8 percent discount rate is to say that it is indifferent between an additional dollar today and an additional 1.03125 dollars one year hence. Looked at the other way around, a dollar one expects to receive in the future is less valuable than a dollar one receives today—with the discount rate measuring how much less valuable.

The discount rate used in these calculations has been established by Congress; it is 3 1/8 percent, the rate applicable to projects authorized in 1962. The rate designated by Congress for projects authorized in fiscal year 1975 is 5 5/8 percent. Whether projects such as Tocks, authorized in the early 1960s but not yet under construction, should be reevaluated using current discount rates has been a matter of controversy. What is clear is how important the discount rate is to the benefit-cost calculation.

For example, Table 4–2 shows how the annual average construction costs would be affected by changes in the discount rate. The remaining annual costs and all of the annual benefits are nearly constant over future years and hence are hardly altered by a change in the discount rate. Assuming for ease of illustration that they are strictly constant, the sensitivity of the Tocks benefit/cost ratio to

Table 4–2. Discount Rate Sensitivity, Tocks Construction Costs

Discount Rate (%)	*Average Annual Construction Costs* (millions of dollars)
3-1/8	13.1
5-5/8	22.3
6-7/8	27.5
10	40.0

Note: These calculations are based on a project life of 100 years and a total construction cost at the start of the project of $400 million.

Table 4–3. Discount Rate Sensitivity, Tocks Benefits and Costs

Discount rate (%)	*Average Annual Benefits* (millions of dollars)	*Average Annual Costs* (millions of dollars)	*Benefits/ Costs*
3-1/8	29.0	18.3	1.6
5-5/8	29.0	27.5	1.1
6-7/8	29.0	32.7	0.9
10	29.0	45.2	0.6

Note: These calculations are based on a project life of 100 years, a total construction cost of $400 million, and the approximation that average annual benefits and operating costs are not significantly altered by changes in the discount rate.

the discount rate may be readily calculated. The results are displayed in Table 4-3 (which may be compared to Table 4-1).

Because of the power of a change in discount rate to affect the benefit-cost ratio, great significance is attached to the discount rate by both advocates and opponents of federal projects, and it becomes an instrument in the political debate. Often the underlying allocative role of the "price" is overlooked as, for example, when conservationists opposing dams will argue for a high discount rate, although this contradicts their normal sensibility, which attaches great weight to the future. Similarly, persons who advocate federal projects at the time of slack economic conditions are often tempted to support low discount rates as a shortcut means of enhancing the calculated economic benefits of the projects.

The Concept of Average Annual Benefits and Costs. The benefit and cost figures in Table 4–1 are average annual equivalences to the variable stream of benefits and costs one will encounter in practice. Roughly speaking, an average annual benefit may be thought of as that constant amount of dollars one would be willing to accept each year instead of the real, variable stream of benefits. An average annual cost similarly represents the constant annual payments one would be willing to expend instead of the real, variable payment schedule. The mathematical details are in Boxes 1 to 6.

3. Calculation of Costs

The Average Annual Costs. The initial construction of the dam, reservoir, and first stage of the recreation area is estimated to take seven years and to cost approximately $400 million including inter-

Box 1. The Calculation of Average Annual Benefits and Costs

If B_1, B_2, and B_3, . . . , B_N represent the stream of real benefits for years 1, 2, 3 . . . , N where year 1 is the first year after the dam/reservoir construction is completed and year N represents the project life, then the average annual benefit Ba is derived by the expression:

$$\sum_{i=1}^{N} \frac{B_i}{(1+r)^i} = Ba \sum_{i=1}^{N} \frac{1}{(1+r)^i}$$

where r equals the discount rate. In words, Ba is the constant annual dollar flow, over the project life, which has the same discounted value as the actually anticipated flow of dollar benefits. Usually, the stream of benefits varies from year to year; if it should be constant, $B_1 = B_2 = B_3 = \ldots = B_N$, and then the average annual benefit Ba would be, as we would expect, simply this constant.

Average annual costs are calculated in an analogous way, although, for apparently traditional reasons, the flow of construction expenditures and operating expenditures are usually calculated separately.

Thus, if initial construction costs are C_O, the average annual construction cost, $\overline{CC}a$, is calculated by:

$$C_o = \overline{CC}a \sum_{i=1}^{N} \frac{1}{(1+r)^i}$$

And, the average annual operating cost, $\overline{OC}a$, is calculated by:

$$\sum_{i=1}^{N} \frac{C_i}{(1+r)^i} = \overline{OC}a \sum_{i=1}^{N} \frac{1}{(1+r)^i}$$

est charges paid during the construction period. The composition of this $400 million figure is summarized in Table 4–4.

The average annual cost associated with these capital costs is $13.1 million. If one adds to this, the annual costs for operations and maintenance and for planned expansions of the recreation area, one ob-

Table 4–4. Summary of Capital Costs of Tocks Project (1973 prices)

First Cost	(millions of dollars)
Lands and damages	93.5
Relocations (roads)	44.2
Reservoir	10.5
Dam	98.2
Fish and wildlife	7.1
Power plant	28.4
Roads	0.3
Levees and floodwalls	20.0
Pumps	6.5
Recreation	24.4
Engineering and design	14.2
Supervision and administration	11.8
Miscellaneous	1.4
Total	360.5
Interest During Construction	39.5
Total	400.0

tains the total average annual costs of the Tocks project, $18.3 million.

The Losers. The cost figure that most needs explanation is the first one in Table 4–4—the $93.5 million associated with lands and damages. This refers primarily to the purchase of private lands by the federal government. However, a moment's reflection will persuade the reader that it is a figure that very imperfectly measures the human costs of the purchases. As with most benefit-cost analyses, the Tocks calculations tend to conceal how the benefits and costs of the project will actually be distributed over individuals—who will win and who will lose.

It is especially striking in the Tocks case how little analytic attention was devoted to the impact of the project on the people who live in the immediate vicinity of the dam, the group who would be most deeply affected for good or for ill. Some of them would gain from the project and welcomed the dam, but many of the local residents saw themselves as victims. They viewed the costs of the dam not in terms of expended public monies but in terms of lost homes, dissolved communities, and a vanished life style. The very act of government purchase of land in the vicinity of the dam site carried with it untold bitterness toward the government. In almost every phase of the purchasing process, local residents claim that the government has acted unwisely or unfairly.

Several of the property owners were simply unwilling to move at

Box 2. Calculation of Costs

The total initial construction cost in year 1 = \$400 million. This is turned into an average annual construction cost $\overline{CCa}$ by:

$$\$400\text{ M} = \overline{CCa} \sum_{i=1}^{100} \frac{1}{(1+r)^i}$$

For r = 3 1/8 percent, $\overline{CCa}$ = \$13.1 million.

To this number must be added the average annual costs, $\overline{OCa}$, due to operations and maintenance (O & M), major replacements, etc. These total to \$2.8 million annually making a total of \$15.9 M average annual cost associated with the dam, reservoir, and first-stage recreation plan.

The expansion of the recreation area from its initial capacity (four million annual visitations) to its final planned capacity (ten million annual visitations) is assumed to occur in ten equal annual increments costing \$3.2 million each starting in year 1. Given an annual charge of \$1.8 million for O & M, replacements, etc. associated with the additional recreation facilities this gives an average annual cost $\overline{CRa}$ associated with future recreation construction of \$2.4 million:

$$\sum_{i=1}^{10} \frac{3.2 + 1.8}{(1+r)^i} M + \sum_{i=11}^{100} \frac{1.8M}{(1+r)^i} = \overline{CRa} \sum_{i=1}^{100} \frac{1}{(1+r)^i}$$

For r = 3 1/8 percent, $\overline{CRa}$ = \$2.4 million.

The total costs of the project are, thus, $\overline{CCa} + \overline{OCa} + \overline{CRa}$ = \$13.1 M + \$2.8 M + \$2.4 M = \$18.3 million.

any "reasonable" price. They felt that the taking of intangible or uniquely personal attributes of their property could not be compensated by the market assessment. In addition, some of them felt unfairly overwhelmed by a bargaining situation which pitted them as individuals against the apparently infinite, impersonal, implacable, and experienced resources of the federal government. This was especially true of the many elderly persons in the population not accustomed to pressure tactics and adversary procedures; the personal costs of fighting the government's assessment in time, legal fees, and mental anguish seemed higher than any monetary gain they could expect from protracted bargaining.

Missing from the calculation of costs is any accounting of the unusual delays and uncertainties which have plagued the Tocks project. The slow and sporadic removal of scattered properties has had a particularly debilitating effect on the provision of services in the valley communities. When a property is purchased, it is removed from the tax rolls, although the residents often remain. These circumstances hamstring the local authorities, and the maintenance of adequate police and fire protection and of road services for the tourists and remaining residents becomes nearly impossible. The police situation was alleviated in part by the appearance of federal marshalls and rangers, but they were usually on duty during daylight hours only, and fear of violence from vandals and squatters became widespread among the citizenry.

The impact of the project, however, is more than unfair assessments, reduced police services, and vanishing jobs. Listen to the words of two local residents discussing the land acquisition:

> They've made a ghost town of Bushkill. They've bought our land and torn down all our buildings in favor of a national park. Most of the people here don't like to see it come. We seen the store go, we seen the village go . . . and the people we've known all our lives, we seen 'em moving out. We don't like it. It makes all of us sad to see these beautiful things torn down (Ray Steel, age 66).

> . . . we had to move my parents. They tore it down, the government. It's been leveled—the wood house, the smoke house, the hog pen, the outhouse, the spring house. That spring house was worth a million dollars. It had never gone dry. And that was good water. . . . (Charlie Garriss, age 38).

Such rootedness and sense of stable community are common throughout the valley. Much of the charm and uniqueness of the valley is in these people and their structures, a charm the residents did not believe could be preserved by a "wilderness" preserve or nature enclave. The valley had been settled, farmed, and subtly altered by man since the 1600s, and the bottom land farms and stone houses seem as much a part of the valley as the maple trees and river.

This simple description of some of the human costs that lay behind the first item of Table 4–4 tries to touch a note usually and deliberately kept out of benefit-cost calculations. The information and feelings conveyed by such descriptions are surely less objective then the $93.5 million. But are they therefore any less valid? We return to this question in section IV.

4. Calculation of Benefits

Recreation. The WRC guidelines (with the grandfather clause) stipulate an average recreation benefit of $1.35 per visitor day; the annual benefit for a given year would thus be $1.35 multiplied by the expected number of (net) visitations for that year. In the calculation, the Corps assumed that in year 1 (the year the dam is completed) the annual visitation would be approximately four million and that it would grow in ten equal stages to approximately ten million by year 10. This is consistent with relatively long-standing Corps and Park Service plans to expand from four large beaches at the outset of the project to an eventual ten such beaches.[d] With these assumptions, the calculation of recreation benefits is straightforward: the average annual net recreation benefits are $11.7 million.

Box 3. Calculation of Recreation Benefits
(in millions of dollars)

$$\sum_{i=1}^{10} \frac{(4+\frac{6}{10}\,i)\ \text{x}\ \$1.35}{(1+\text{r})^i} M + \sum_{i=11}^{100} \frac{10\ \text{x}\ \$1.35}{(1+\text{r})^i} M = B_R \sum_{i=1}^{100} \frac{1}{(1+r)^i}$$

For r = 3 1/8 percent, B_R = $11.7 million.

There are several critical assumptions behind this apparently simple procedure. Perhaps the most problematic is the average value adduced for a visitor-day. This average follows directly from the schedule set forth by Congress in Senate Document 97, the guideline to benefit-cost calculations preceding the recent WRC publication. However, the numbers so set forth are highly arbitrary; the first director of the national recreation area believed they could as well have been ten times as high ("it's all make believe to put these things in dollars and cents anyway"); and indeed there has been hitherto little persuasive work on recreation benefits one way or the other. The recent WRC guidelines suggest a somewhat higher scale: $0.75 to $2.25 per day for "general" recreation (swimming, picnicking, most fishing), and $3.00 to $9.00 per day for "special" recreation (certain types of fishing, hunting, etc.).

[d]The recreation plan is described more fully (and more critically) in Essay 10.

Table 4–5. Values of a Recreation Day

Activity	*Percent of Visitors*	*Value*	*Benefit*
Sightseeing	20	$0.65	$0.130
Fishing	6	1.20	0.072
Camping	7	1.40	0.098
Hunting	4	2.50	0.100
Swimming and picnicking	50	1.50	0.750
Power boating	9	1.50	0.135
Sailing and canoeing	3	1.50	0.045
Hiking and nature study	1	2.00	0.020
Total	100		$1.35

Source: General Accounting Office, "Review of Tocks Island Reservoir Project," October 1969.

The schedule of dollar values arrived at appears to be a political compromise among the several federal agencies concerned with recreation, and Congress, the guidelines for the determination being quite arbitrary. That is, the value of a recreation day should not be so high as to overwhelm the other benefits of dam building (and thereby make the whole calculation look ridiculous), nor so low as to fail to represent at least some of the real worth of recreation. The result is an interesting phenomenon, a "political number." It is, of course, questionable whether *any constant value* for a visitor-day makes sense, since such a value implies a linear relationship between visitations and recreation benefits: the more the merrier.

The assumption regarding the expected number of annual visitations is also problematic. The estimates presumably reflect a judgment of the environmental carrying capacity of the recreation area, a judgment that has nowhere been explicitly defended. Nor do the plans provide any guide to how the recreation load will actually be limited if the demand for recreation (as expected) outstrips the design load of the park.

Yet another critical issue associated with the recreation calculations is the determination of the recreation alternatives to be compared. The Corps compares the benefits of a recreation area centered about the reservoir with the present relatively low intensity recreational use of the Water Gap region. This is sensible if one is trying to determine whether to attach a recreation area to the project *after construction of the dam and reservoir have been assumed.* But the procedure is not acceptable if one believes that a recreation area of some sort will be developed regardless of the fate of the dam. In that case, the benefits of the reservoir-based recreation area should be

compared to the benefits of a natural systems recreation plan based upon the river. Were this done, the recreation benefits attributed to the project would almost certainly be significantly reduced.

The calculation, like nearly all benefit-cost analyses, says nothing directly about the distribution of benefits: for example, whether the visitors to the recreation area will be predominantly urban poor, suburban affluent, working class, or white collar. Although some of the dam proponents have argued that the recreation park will serve mainly the less affluent urban dwellers in the New York, Philadelphia, and Trenton areas, the little relevant analytic work that has been done does not support such a contention. On the contrary, the urban poor especially could not be expected to travel the distances necessary unless very good public transportation were provided, contingencies not in the project plans.

Water Supply. Water supply benefits are based on the costs of a most likely alternative equivalent water supply facility. This has been judged to be a single-purpose dam/reservoir at Wallpack Bend and a subimpoundment at Flat Brook, the total storage capacity of which would be identical to that of the Tocks reservoir, 425,600 acre feet. It is assumed for purposes of calculation that this alternate water supply would be privately financed at a discount rate of 4 1/2 percent, or 1 3/8 percent above the 3 1/8 percent used for the Tocks project.

The focus on private finance (if not necessarily the discrepancy in discount rate) is partly justified by the absence of any express congressional authority for the Corps to build single-purpose water supply systems. It is also noteworthy that the least cost alternative is, like the discount rate, fixed at the time of authorization; thus, even if new technology in the past decade permitted an even better single purpose alternative, this would presumably not be reflected in the calculation. However, it is not these grandfather clause issues that govern the calculation. The requirement of identifying and pricing the least cost alternative makes sense only if one is certain that an equivalent amount of water will be supplied regardless of the fate of Tocks.

This method of calculation makes the calculated water supply benefits independent of the actual demand schedule for water in the Delaware Basin service area. The method also disguises the uses to which the extra water is to be put. The actual calculation of water benefits derives from an assumed construction cost of an alternative facility of $211 million. The total average annual cost for the alternative, and therefore the total average annual benefit for water supply is then $10.2 million.

Box 4. Calculation of Water Supply Benefits

$$\$211\,M = \overline{CC}w \sum_{i=1}^{100} \frac{1}{(1+r)^i},$$

where $\overline{CC}w$ = average annual cost of constructing the lowest cost alternative dam and reservoir.
For r = 4 1/2 percent, $\overline{CC}w$ = \$9.6 million.
Annual operating costs = \$0.6 million.
Total cost of alternative water supply = \$10.2 million.

Power. The power benefits are also derived by calculating the cost of the most likely alternative power plant. The Federal Power Commission supplies the Corps with the necessary data—the cost per installed kilowatt for dependable (i.e., continuous) and for interruptable capacity, as well as a cost per kilowatt hour for fuel. The benefits are based on the average annual net benefits of the least expensive alternate steam plant, financed by the federal government at a discount rate of 3 1/8 percent. Table 4–6 summarizes the data.

Table 4–6. Power Benefits

Dependable capacity	38 MW at \$24/KW	= \$0.9 million
Interruptable capacity	32 MW at \$12/KW	= \$0.4 million
Energy value	300,000 MWH at \$.006/KWH	= \$1.9 million
Total average annual benefits		\$3.2 million

Box 5. Calculation of Power Benefits

The expected annual benefits are a constant \$3.2 million. The average annual benefits are thus the same, \$3.2 million.

$$B_P = \sum_{i=1}^{100} \frac{1}{(1+r)^i} = \sum_{i=1}^{100} \frac{3.2M}{(1+r)^i}$$

B_P = 3.2 million.

These benefits derive from the 70 MW directly obtainable from the dam and waterhead; they do not include consideration of the pumped-storage potential provided by the Tocks project (as described in Essay 7).

Flood Control. Flood control benefits are defined as the expected flood damage to those structures in the Delaware flood plain that are protected by the Tocks project but are not without it. The total value of the structures in jeopardy has four components: (1) the current value of the structures in the flood plain, (2) new developments to be expected, (3) increases in damageable assets (consumer goods) attributable to increased affluence of flood plain inhabitants, and (4) increases in land value due to increased or higher utilization of property in the flood plain made possible by the provision of flood protection. The benefits attributed to the dam weight these components by the probability of various levels of flooding in the absence of a dam. The average annual flood benefits thus calculated is $3.8 million, or less than 14 percent of the total project benefits. Given the historic importance of flood prevention as a driving force to the Tocks project, this is a surprisingly low figure.[e]

Box 6. Calculation of Flood Control Benefits

Flood Plain Benefits (Benefits at year shown, in millions of dollars)

	0	*50*	*100*
Downstream (Penn.)	1.3	1.7	1.7
Downstream (N.J.)	1.0	1.0	1.0
Upstream	0.5	0.7	0.7
Affluence (18.83% of above)	0.5	0.6	0.6
Land Enhancement	0.1	0.2	0.2
B_i = Total Annual Benefits	3.5	4.1	4.1

Then:

$$\sum_{i=1}^{100} \frac{B_i}{(1+r)^i} = B_F \sum_{i=1}^{100} \frac{1}{(1+r)^i}$$

For r = 3 1/8 percent, and using a linear extrapolation between years 0 to 50, B_F = $3.8 million.

[e]The politics, economics, and physics of floods are discussed further in Essays 2, 3, and 6.

Two additional features of this calculation deserve mention. First, it is implicit in the calculation that if the dam encourages people to move into the flood plain, this increase in flood plain usage would increase the estimated flood reduction benefits. Conversely, flood plain zoning diminishes the calculated flood control benefits. Thus, if Pennsylvania were to follow New Jersey in enacting such zoning legislation, the benefits of the Tocks project would thereby be reduced.

It is interesting to note that the potential saving of lives and the feeling of security that flood protection could bring do not enter the computation, even though they are undoubtedly the primary reasons for spending money on flood control and the generators of much of the political pressure for it. Instead, the protection of property, which can be calculated with some objectivity and consistency, becomes the target of analysis.

5. Why Just These Benefits and Costs?

A large number of benefits and costs are not considered in the national income balance sheet of the benefit-cost calculation. These are most evidently those factors for which it would be impractical and unpersuasive to assign a monetary value.

Most kinds of environmental damage or improvements caused by the project, such as the expected attrition of shad, are examples of such kinds of intangibles. Scientists cannot predict the ultimate scope or effects of these impacts, much less attribute an economic cost to them, a predicament recognized in the new water planning guidelines that establish a separate balance sheet for the environment. Even when one can trace the changes in the environment to be expected, it remains unclear how to attribute costs—whether even to try to measure harm to animals, plants, and the natural landscape in homocentric terms.

Large scale, systemic social impacts also cannot readily be measured. Everyone recognizes, for example, that the dam would alter the rural character of the communities near the dam site, affecting the life styles of the inhabitants, but whether for good or for ill, substantially or slightly, appear questions beyond the reach of the economists. Still another class of factors that seems to defy benefit-cost measurements are the elusive changes in the values and attitudes of the affected parties that may be expected consequent to the dam. For example, the dam will remove a burden of insecurity from the flood plain inhabitants, alter the recreational values of many in the wider impact area, expand and constrict the horizons of varied groups of citizens in the Basin states, all consequences not readily

countable in monetary terms. In addition to these intangibles, certain benefits and costs are circumscribed by the congressional guidelines: for example, a monetary benefit for improved water quality (say, in the Delaware Estuary) due to increased fresh water flow provided by a dam project can be claimed only under extraordinary conditions.

6. Development of the Tocks Benefit-Cost Calculation

The Corps included an elaborate benefit-cost study in its massive HD 522 review of Delaware Basin water resources published in 1961. This was prelude to congressional authorization of the Tocks project in 1962, and since that time the Corps has each year presented to Congress an updated benefit-cost calculation of the Tocks project. After the initial study, this updating has been mostly routine except for 1970 and 1973–74 in which significant changes were either effected or considered.

Reflecting the new water resource planning guidelines then being formulated, the Corps, at the time it undertook its review of the Delaware Basin, placed considerable emphasis on multipurpose planning, and especially on the recreation potential of federal water projects. Thus, although the Delaware Water Gap recreation area was not authorized until 1965, three years after Congress authorized the Comprehensive Plan, such an area was contemplated by the Corps from the beginning, and indeed, even in 1962, recreation represented a high fraction of the expected benefits of the Tocks project. The initial benefit-cost analysis, therefore, already displayed the essential shape of all subsequent analysis, the listing of the four specific benefits—recreation, power, water supply, and flood control. The initial study also employed benefit-cost analysis as a planning device, to optimize within rigid constraints the distribution of projects within the Basin. The formal benefit-cost framework was thus used not so much to justify a particular project, but rather as a means of comparing a large number of alternatives.

Between 1963 and 1969, the summary Corps benefit-cost calculation for Tocks looked as shown in Table 4–7. The sudden jump in benefits between 1969 and 1970 was due to a reestimate of the recreation benefits. When it appeared in 1969, it led the chairman of the Senate Public Works Sub-Committee of the Committee on Appropriations, Senator Ellender, to request an audit by the General Accounting Office of the Corps' plan for Tocks. The audit was duly published in 1969. The chief findings of the GAO study were that the Corps: (1) had inappropriately invoked benefits and costs relating to the ultimate development of recreation facilities

Table 4–7. Schedule of Estimated Annual Benefits and Costs

Fiscal Year	*Total Annual Benefits* (millions of dollars)	*Total Annual Costs*	*B/C Ratio*
1964	11.6	4.9	2.4
1965	11.6	5.0	2.3
1966	12.0	5.1	2.4
1967	12.5	6.9	1.8
1968	13.9	9.1	1.5
1969	14.4	9.1	1.6
1970	22.9	11.3	2.0

Source: GAO Study, "Review of Tocks Island Reservoir Project," October 1969, Appendix IV.

in the recreation area, not just those facilities immediately bordering the reservoir; and (2) had substantially understated present recreation visitation to the area. The major GAO claim was that the Corps did not have authority to include the entire recreation area in its calculation: the benefits flowing from the facilities not directly related to the reservoir that would have to be built and operated by the Park Service should not be claimed by the Corps. In effect, the GAO would have reduced the claimed recreation benefits by deleting benefits for the upland part of the park that could be used for recreation with or without a reservoir.

The corps responded that its procedures were in fact reasonable: that the increase in recreation benefits did reflect a past error in the calculation of recreation benefits, but that the new procedures correctly followed congressional guidelines in planning for the best use of water resources "to meet all foreseeable short and long term needs within the projects' zone of influence over its economic life"; and that the Corps' figure of current visitation (183,000) still seemed more reasonable than the GAO estimate (1,200,000).[2] The Corps' first argument rested on the presumption—not shared by the dam's opponents—that the recreational value of the uplands was largely dependent on the presence of the reservoir. Upland recreation benefits were therefore seen by the Corps as attributable to the reservoir. In any event, the Senate took no action as a result of the GAO study and the Corps essentially ignored the findings of the study.

As described in Essay 3, the New Jersey governor, William Cahill, insisted in 1972 that the recreation plan design load be reduced from ten million annual visits to four million. Pursuant to this Cahill condition, there had been persistent speculation that the Corps and NPS were redoing the benefit-cost analysis. It was thus somewhat of

a surprise that the calculation released for fiscal year 1975 did not reflect this scaledown at all. This has been defended by the Corps on grounds that the park plan *at the outset of the project* did meet the Cahill concerns; the expansion would presumably take place as planned only if the initial influx of visitors was not unduly disruptive. The Corps thus argued that Cahill and his supporters simply did not fully appreciate the several step development anyhow contemplated for the recreation area. The Corps' belief is that the demand for recreation will be so intense once the first stage of the recreation area is constructed that its expansion will be inevitable whatever the wishes or presumptions of an ex-governor who would be at least a decade out of office at the time the dam construction was completed.

Thus neither the plans for the recreation area nor the accompanying benefit-cost calculation was changed significantly. However, since the Corps analysis was accompanied by detailed assumptions, it did permit an easy calculation of the benefits and costs should the recreation area, despite all, be frozen at four million visitations annually. Such a situation with other assumptions intact would reduce average annual benefits by $6.3 million and costs by $2.4 million. The benefit-cost ratio would be reduced from 1.6 to 1.4.

7. Open Questions

Even this briefest summary raises several questions regarding the character and power of benefit-cost calculations. These may be grouped into two classes of issues, each of which will be addressed in the following sections.

1. What in principle can benefit-cost analysis tell us about the project under investigation; what is its prescriptive power? In particular, how can benefit-cost analysis deal with the problem of equity and distribution; how can the analysis treat unrepresented actors, such as future generations, potentially affected by the project; and how can an analysis which purports to measure the benefits and costs of a future project and its uncertain train of developments deal with a situation in which peoples' conceptions of that future and their values are in a continual state of flux?
2. What are the principal limitations of benefit-cost analysis in practice? In particular, can the complex web of benefits from a project such as Tocks be rationally partitioned without serious distortion of the results; can there be a satisfactory means of defining all the relevant alternatives to the project; are the methods of measuring benefits, such as for recreation and water

supply, persuasive when there is no direct market test; and in what instances can intangibles be incorporated into the central benefit-cost calculation?

III. THE BOUNDARIES OF ANALYSIS: CONCEPTUAL PROBLEMS

1. The Ideal Benefit-Cost Analysis

In principle, a benefit-cost analysis may be constructed in the following way: for each member of the relevant group there is calculated the maximum amount of money he would be willing to give up to see the action in question (say, a dam) undertaken. For some people, this amount will be positive (they favor the project), while for others it will be negative. In the latter case, a negative amount may be thought of as the minimum compensation that person would accept to see the action undertaken. If the *sum* of these amounts over the entire society is positive, the action is said to pass a benefit-cost test. In the case of mutually exclusive alternative actions, the one for which the sum is highest is said to maximize net benefits.[f]

This brief characterization of benefit-cost analysis ignores some fine points, but the basic logic of the statement is correct. One thing that might be noted right away is that the consequences of the public decision to be taken account of here include absolutely everything that anybody in the relevant group cares about. There is no distinction to be made between tangible and intangible values or effects, nor is there any reference to the type of consideration that may legitimately be considered. One person's deep sensitivity to nature is as valid as another's wish for economic development.

2. The Prescriptive Power of Benefit-Cost Analysis

Why "should" the decision that maximizes net benefits thus defined be undertaken? The argument runs as follows: If the project P has larger net benefits than another action A, it will, by the use of compensating payments, always be possible to make everyone better off under P than under A. For example, suppose that a benefit-cost

[f]The technique of analysis is to reduce everything to a common denominator, which we have called dollars but which could be some other numeraire, provided it is a "commodity-like" substance in the sense of being redistributable from person to person. Strictly, it may matter whether this numeraire is dollars or apples or ice water. But the analytical problems introduced by this choice are not crucial to the logic of the claim that those decisions should be made which pass a benefit-cost test or, in the case of mutually exclusive alternatives, that the decision should be made which maximizes net benefits.

analysis of the various alternative possibilities of the Tocks Island site were to reveal that a particular configuration of dam, park, and water supply system generated a net benefit of nine million dollars per year relative to some no-dam plan.[g] And let us suppose that the people who would be the main gainers from the no-dam plan would be the hikers and campers and the people who would gain most from the dam plan would be boaters and developers. Our study would then have told us that it would be possible, if we wished, to build the dam, take money away from the boaters and developers, and distribute that money to the hikers and campers, with the net result that after the transaction *everybody* would consider the outcome preferable to the recreation area plan without the dam.

The idea that in every situation one should choose the alternative generating the largest net benefits is sometimes called the criterion of hypothetical compensation. It is a criterion that makes a certain amount of sense when the distribution of gains and losses is so organized that it satisfies some principle of fairness or justice. In this case the overall social well-being might fairly convincingly be said to be maximized when the social pie is as large as possible. But real world projects such as the Tocks Island Dam do not come equipped with schemes for distributing the benefits and costs in any way significantly separable from the particular pattern that comes naturally with the project.

Returning to our hypothetical choice between the dam and no-dam plans, in the one case the people to benefit would be boaters and developers, and in the second case hikers and campers. Even though compensation is a logical possibility, in choosing between two such plans we are frequently choosing between benefits to one group of people and benefits to another. Where the assurance of the equitable distribution of benefits is not plausible, the criterion of maximizing the benefits is not very compelling ethically.

Indeed, benefit-cost studies scarcely ever include substantial information about the identity of gainers and losers from the project; when these individuals are known, any given policy maker might properly reject one proposal in favor of another with smaller net benefits if he favored the distributional effects of the latter. This is of course also true of the individuals who see that they will be among the losers. Their objection to the analysis is entirely legitimate, and it is to be expected, as is well illustrated in the Tocks controversy.

[g]It is a well known proposition of welfare economics that we cannot, strictly speaking, measure the "size of the pie" independently of its distribution. We would like to pretend that this analytical problem does not arise here, in the interest of isolating our more fundamental (and simpler) point.

Nevertheless, there may well be reason to be concerned with the size of the total benefits apart from any explicit redistribution scheme. This is especially so if the political system *as a whole* operates to effect the redistribution. It may be argued, for example, that while it is true that in any one case there may be no particular virtue attached to the gainers, nor any particular reason to subject the losers to the losses from a given decision, over the long run a sequence of decisions will occur such that any one individual is randomly situated with respect to decisions. That is, following a rule over time of choosing actions to maximize the net benefits will also eventually maximize everyone's real wealth. About this claim it can only be said that it might be correct. One could argue that those economists who favor a free enterprise system on the grounds of its efficiency do so with some such argument in mind. It is a position that deserves to be stated in an operationally testable form.

In general, people probably are partially aware of the sharing arrangements and of the way in which the political process functions to reallocate gains and losses. It seems clear that politicians are going to pay attention to the identities of the gainers and the losers and not simply to the aggregate sum of the gains. They are not likely to be persuaded of the virtue of a project whose gainers all live in another district. But the fact that a project has positive net benefits does tell politicians something, namely that there is the potential for a profitable agreement with other decision makers that would produce mutual benefits. The losers from the project will agitate for compensation and sometimes get it.

In the Tocks case, the recent proposal of the Delaware River Basin Commission to include the 75-mile stretch of the Delaware just above the Tocks reservoir in the Scenic River Preservation Act might be viewed as a compensating adjustment favoring many of the conservationists especially outraged by the Tocks project. In familiar economic language, such a finding of positive net benefits implies the possibility for gains from trade. In the political context, trade may occur in the form of log-rolling.

The prescriptive power of the benefit-cost calculation is further undermined by the realization that the ability of a project to pass a benefit-cost test could depend sensitively on the present income distribution of the affected citizens and more particularly on the preferences of very tiny minorities. That is, the values people will place on a projected change will in general depend on their income, and for some persons (with sufficient current comfort), no practical compensation may be sufficient to persuade them to support a given public project. In such a case, given our idealized definition, the

project could not pass a benefit-cost test, which may or may not suggest whether the project should be undertaken anyway. One's feelings here are again dependent on how one assesses the merit (and political power) of the project's beneficiaries and victims.

3. Who Counts?

The benefit-cost analysis ideally reflects the preferences of all the individuals and agents in "the relevant group." But who are they? Who should, in effect, vote on the Tocks Island Dam? Should the analyst take into account the preferences of persons far from the dam site—and what of the claims of animals, trees, stones? Welfare economics is mute on this issue, a silence connected with the ethical weakness of the criterion of hypothetical compensation. If one takes the view that the object of the analysis is to determine whether the status quo is capable of modification in a way that is beneficial to all agents, this question is in principle answerable for any given group of agents, and that is all there is to the matter.

On the other hand, if one has decided to use the principle of hypothetical compensation as the basis for decisions, then it becomes very important to establish which individuals and agents are included. Most economists would have some difficulty in imagining an analysis that included the preferences of stones, for the simple reason that it is rather difficult to attribute any meaning to the idea, and western economics, at least, regards the evaluations of individual human beings as paramount. However, it must be conceded that for purposes of welfare economics the concept of "agent with preferences" is rather like the concept of a point in Euclidian geometry: the mapping of theoretical constructs onto real, existing entities is a matter of art, not of logic.

A special problem, which applies to the ethical force of benefit-cost analysis, is the representation of future generations. This problem is principally a practical one: from a logical point of view there is little question that future generations can count. The monetary measures of benefits and costs attributable to alternative courses of action in the present, but incident upon individuals not yet part of the consulted individuals and agents, can count as much as any others and be added into the reckoning-up of aggregate benefits and costs in an ideal analysis.

But future generations' interests are necessarily looked after by those alive today, and there is the practical problem of predicting how future generations would evaluate alternatives. Most environmentalists at least will guess that future generations would value the environment highly. Future generations, the argument goes, are

likely to be wealthier than the current generation, more able to afford environmental protection, more inclined to sustain a lesser rate of economic growth—and likely to have less natural environment to protect. The practical problem of weighting the future is distilled in the discount rate, the choice of which has long been a subject of controversy. This aspect of the problem is discussed later in this essay.

IV. THE BOUNDARIES OF ANALYSIS: PERSISTENT LIMITATIONS IN PRACTICE

It is all well and good to construct an ideal benefit-cost analysis through a series of interviews with everyone in the relevant group, but in practice the necessary data must be inferred by indirect means. The practical difficulties, we shall see, are only a minor extent those of economic theory. It is useful to distinguish four steps that must be undertaken, explicitly or implicitly, in implementing benefit-cost analysis.

1. Define the zero point: that is, attempt to specify the developments that will take place in the absence of any positive alternative decision by the political agency involved.
2. Define and describe the set of mutually exclusive alternatives open to choice by the agency.
3. Decide which of these alternatives are to be analyzed and determine a classification of the benefits and costs which makes the analysis manageable.
4. Develop methods of producing answers to the question: How much net numeraire good is equivalent in the aggregate for each of the alternative choices available relative to the baseline status quo.

For the most part, economic theory is called into play only in the last step.

1. Defining the Baseline

Although it is unusual for a benefit-cost study to include any detailed description of the baseline from which the alternatives are measured, greater precision in this respect could reduce ambiguity and confusion in subsequent steps. In one respect, fortunately, the precise choice of baseline is unimportant. Benefits and costs are like electric potential—it is only differences or changes that count. As long as *some* consistent baseline is adopted, the results should not be sensitive to which one it is.

Normally the baseline adopted by an agency doing benefit-cost analysis, at least implicitly, is a future in which the agency takes no action. This future, then, by definition has net benefit zero. Naturally, estimates of what will happen if the agency does nothing are subject to great uncertainty. If, in the absence of the Tocks Island Dam project, the state governments might construct a recreation area at the same site, should this be considered part of the description of the baseline? If the null action has uncertain consequences that can be expressed as some distribution of probabilities, then ideally all alternative actions should have their benefits expressed as distributions corresponding to the distribution of baselines.

2. Defining the Alternatives

The invention of alternatives is probably the most crucial step in benefit-cost analysis. Analysts, for example, will almost always have considerable discretion to choose the boundaries of the project under consideration. In the Tocks case, the Corps of Engineers, following accepted practice, did not include in the benefit-cost analysis either the network of highways required to service the recreation area or the sewage treatment plants required to make any Tocks Island reservoir useful for recreational purposes. It is perhaps an interesting commentary on the use of analysis in actual decision processes that the inclusion of some of these "external" effects of the construction of the project have been forced into the analysis by its users. It needs little thought to convince oneself that these secondary influences of a project are just as integral a part of it as the primary ones from the point of view of an ideal benefit-cost analysis.

The problem of developing and defining a set of alternatives is one of the most difficult steps in doing analysis, relative to which the other aspects are in principle mechanical. But here science has little to say and art and imagination are the critical factors. The discovery of institutional methods for generating useful and imaginative alternatives in any decision situation is an area that, while it has commanded considerable imaginative thought already, no doubt will reward further efforts at innovation. For example, devices such as the design competitions conducted traditionally in architecture might be usefully extended to stimulate the generation of alternative designs in other contexts.

3. Choosing Which Alternatives to Analyze

When one considers the extraordinary complexity and difficulty of performing the analysis of even one specified alternative relative to the status quo, one comprehends the tendency of agencies to

reduce an analysis to the close scrutiny of a single plan. Given this difficulty, perhaps the most important point to recognize is that analysis must continue beyond a first effort and should not simply stop after one particular study has been completed. One should view a given study as merely one part of the process of economic analysis and not imagine that one study is *the* economic analysis.

We have already mentioned the utility of subsequent criticism in revealing undiscussed or unanalyzed alternatives, and we must add that subsequent controversy is likely also to encourage analyses of the alternatives discovered. These are commonsense notions, which are nonetheless not fully accepted by public agencies such as the Corps, who have tended to see each of their benefit-cost analyses as the last word, beyond improvement, refinement, and criticism by others—not as the first step in a series of ever more fertile inventions and analyses.

4. Doing the Calculation

In the absence of a direct interrogation such as suggested by the ideal benefit-cost analysis, the analyst must seek indirect clues of peoples' preferences. The most useful by far of these clues are provided by market prices. The basic approach is simple: if individuals are observed in the market place to exchange one apple for two pears, we conclude that giving anyone an apple is as good as giving him two pears. We can therefore use the observed market price of two pears per apple to place a pear value on changes in apple quantities. Suitably elaborated, this is the logic of using prices to place dollar values on various physical changes.

This is actually the single most important principle used in developing estimates of the answers people would give to the question of how much they would value specified changes in the world. These values are revealed in an indirect way, from individual behavior in the market place. In many instances, it is clear that this manner of discovering preferences cannot so easily be applied. This will be so where there is no established price or market mechanism—that is, when no exchange or trade is feasible. In the Tocks controversy three difficulties of this sort stand out: the choice of discount rate, the calculations of water supply and recreation benefits, and the treatment of intangibles.

5. Discount Rate

It may seem odd to speak of the discount rate as a price, but it is one, exactly like the price of water or electricity, and it has the same function in the analysis: to indicate the rate at which people are

willing to exchange one thing for another. As noted in section II, the rate of exchange being referred to is between dollars of consumption in one period (today) and dollars of consumption at a later period. The difficulty is that the market on which this price is set, usually called the capital market, appears to permit a great variety of exchange rates, from the 15 or 20 percent per annum rates paid on installment loans to the 6 percent earned on savings accounts. Furthermore, there are individuals who are unable to participate in the exchange in question. Generations in the future are not able to participate in the exchange of dollars today for dollars tomorrow.

For this reason, economists have not been able to settle on a definitive discount rate. Even though it is possible under certain precise constraints to decide on a specific discount rate appropriate to those conditions, analysis leads to the conclusion that no single discount rate can be appropriate for evaluating all projects. For practical purposes, some sort of compromise discount rate is necessary, however. Most economists would favor using a discount rate that falls somewhere between the rates received on secure assets by savers and the rates of return earned by profitable corporations. But there is no general agreement on where in-between it should be; and unfortunately—as strikingly shown in Table 4–2 in section II—the choice can make a great deal of difference.[5]

6. Least Cost Alternative: Water Supply

As noted in section II, the water supply benefits of the Tocks Island Dam were derived by calculating the cost of the most probable least cost alternative. It was assumed that certain physical services would somehow be rendered by the economy—delivery of certain quantities and qualities of water—and the question was asked, What costs are *avoided* if these services are obtained from the Tocks Island project? In this case the required services are estimated by relating water use to certain indices of population and industrialization, and projections of the latter are used to project future consumption of water, with no reference to the price of water. The difficulty is that the amount of water used is subject to the economist's familiar first law of demand. When the price is high, less is used. An analysis that takes the quantity of water required as rigidly fixed is therefore not likely to lead to an efficient outcome. Even if one accepts this approach as a reasonable approximation to the ideal, one can ask whether the actual methods used to identify alternative costs are appropriate.

Ideally, one would like to know which are the least expensive methods of producing water that would, in fact, be used if the water

were not provided by the Tocks Island Dam. These would then represent the cost savings produced by the dam. It is rather difficult to know whether the average cost estimates from currently operating water systems are likely to be appropriate measures of these costs. One would suspect that currently used sources are of lower cost than those which would have to be used in the future were the Tocks Island Dam not available as a source of water. The problem of identifying the least expensive alternative ways of obtaining water that would otherwise be used requires identifying how much water would be used, how we would provide it, and in particular how this provision would be provided in sequence over time. None of these steps is easy.

7. Shadow Prices: Recreation

The case of recreation presents an interesting contrast to that of water supply. Whereas there the object of the analysis was to estimate potential cost savings made possible by the presence of the Tocks Island Dam, the recreation services are treated as a net addition to the available totals of recreation services in the economy.[5] The incremental "visitor-days" provided by the full capacity utilization of the Tocks Island recreation facilities were treated as net additions to recreation in the region. Since some of the recreation benefits from the dam would seem likely to take the form of cost savings (just as was the case with respect to water supply), the treatment of recreation services as purely a net addition to the total introduces a possibly significant factor of uncertainty into the calculation.

Available studies rely on a variety of indirect methods for placing a dollar value on a visit to a facility such as the Tocks Island Dam. Necessarily such studies are prepared infrequently and for a very diverse set of recreation opportunities. And while considerable ingenuity has been applied to measuring the value placed on visits in the various cases studied, transferring the results to the particular time and place of the Tocks project is clearly subject to a wide range of error. All the calculation methods attempt, in effect, to establish a "shadow price," which corresponds to answers people would give to our ideal benefit-cost calculation, in which each person who came to the recreation area would be asked the value of the recreation experience to him. This value would be a net figure, with the respondent comparing the value of recreation at the Water Gap with his other recreation alternatives.

It is clear from this perspective that the admission price, and, in

general, the method by which visitors to the park are rationed could affect the calculation of benefits. If the number of daily visitors is rationed (limited) by the admission charge, then the last person who will want to enter the park will be indifferent whether he enters or not: the net value of the Water Gap recreation experience compared to his other alternatives will be roughly equal to the admissions charge, and his "consumer surplus" will be zero.[h] The total social benefits in this case will be the consumer surplus aggregated over all the visitors, plus the public net revenue collected through the admission charges.

If the rationing is effected in some other way than price, the social benefits are likely to be different, depending on the rationing scheme actually adopted. For example, a first come, first served procedure may under some circumstances fill up the park with marginal visitors with no strong preference for the visit, but who live in convenient range of the park. A calculation of benefits that does not explicitly consider the means of rationing the visitors will thus be unreliable. The analysis employed in the Tocks case is flawed in this manner.

8. Intangibles

In practice, most benefit-cost analyses will not deal systematically with factors that are difficult to measure in monetary terms. In the Tocks case there are many such examples: the value placed by a substantial number of citizens on their ability to hike in unspoiled rural countryside, or on the security they would derive from living on an unthreatened flood plain, to name only two. A review of the available instruments for practical benefit-cost analysis does not make one sanguine about the possibility of including these values in a systematic way, even though the theory is unambiguous that such preferences count as much as any others.

While one should perhaps not give up hope of improving upon our indirect measures of the value that people place on such aspects of public choices, there is likely to remain a large element of judgment that must be exercised by those legislators or public officials responsible for making such choices. This gives to the benefit-cost analysis a "residual" character. Since the analyst will be unable to provide an estimate of the equivalent monetary value to (say) losses of amenity, the recipient of the benefit-cost study (say, a public official) must provide his own estimate of the appropriate monetary equivalent of

[h]For present purposes, "consumer surplus" may be defined as the difference between the consumer's net benefits and the price (or admissions charge) he must pay to receive the benefits.

these amenity changes. In effect, the benefit-cost study measures the value not of the actual change, but of that change minus the intangible benefits and costs.

All fields of inquiry relevant to public policy are plagued by this issue of intangibles, in which factors apparently relevant to an assessment of costs and benefits simply cannot be given a measure in dollars or any other common numeraire. National security debates are often dominated by reference to nationalism, national pride, flexibility, etc.—certainly not concepts that can be measured in any sensible way. Similarly, analysts of social welfare programs have never been able to make the benefits of these programs (health care, cancer research, Headstart programs, special remedial reading, etc.) commensurable in dollar or any other terms.[7] Such intangibles will most often stand outside the formal benefit-cost analysis.

Sometimes, as with recreation benefits, there will be an attempt to provide a measure that will permit the benefit or cost at stake to be put into the monetary benefit-cost framework. But in most instances, this will not even be attempted. The value a person places on various experiences crucial to an assessment of environmental issues, such as canoeing, security against floods, solitude, well-watered lawns, backpacking, swimming, visits to historical sites, etc., often does not have an echo in the market place. They are thus intangible, and much of the work on intangibles involves attempts to find surrogate ways for such preferences to be revealed. This effort is sensible (to a point), for it is in principle possible for persons to indicate the value—a money value if necessary—that they place on these experiences. Recreation at Tocks Island is clearly not a priceless experience; and it is well to estimate even imperfectly the cumulative benefits the public attaches to such recreation. Individuals can and do place values on personal experiences, and these values ought to be of prime interest to an analyst.

Certain kinds of personal experiences do not lend themselves at all easily to such analysis, however. Consider experiences that drastically alter the values and preferences of the affected party. (Remedial reading programs for adults could be placed in this category, for example.) It seems much less interesting and less reliable in these cases to learn the monetary value the individual places at a given instant on the experience. It appears equally unrewarding to discover the value a person places on (say) being cured of cancer, as part of an analytic effort to determine how much funding should be put into cancer research.

The impracticality of finding reliable monetary measures becomes even more evident when the alternative futures confronting the affected parties are complex and not well specified. What are the

ecological hazards of the dam? What will be the social impact of the project on the way of life in Warren and Sussex counties? In instances such as these, the preferences of individuals, while important to probe, will depend significantly on the degree to which the alternatives can be understood and made vivid. Preferences will depend sensitively on the individual's degree of knowledge and experience, and may change drastically as the individual thinks more about and learns more about the alternatives actually open to his community. For these decisions involving an entire community, peoples' preferences are likely not only to be unstable and unformed but not easily additive as well. An individual's preference for a particular community life style will, in general, depend on the values his neighbors place on that life style. The collective value a community places on some alternative future will not simply be the sum of the individual preferences of its citizens.

The inability of analysts to construct monetary surrogates for important intangible values has had little perceptible effect on the degree to which they will be regarded or disregarded by policy makers. In the Tocks controversy, for example, policy makers generally seemed appropriately skeptical of the formal benefit-cost studies and perfectly willing to judge the relative importance of intangible benefits and costs without the analysts placing dollar values on them. Whether or not intangible factors get woven into the decision making process depends upon considerations other than the degree to which analysts can concoct some illusory monetary measure for them.

In the Tocks case (as well as others with which we are familiar), four such considerations appeared of particular importance: (1) the analytic richness and vividness with which the intangible benefits and costs could be described in physical terms, (2) the relative importance of the political and bureaucratic constituencies holding strong feelings respecting these benefits and costs, (3) the legitimacy of discourse about the intangible factor, and (4) the preferences and values of the policy makers themselves.

In the first instance, the policy maker seeks as clear and as vivid an understanding of issues as possible; he will want a clear statement of the benefits and costs in whatever terms are possible quite apart from any attempt to assign monetary values. For example, rather than trying to find a monetary measure to describe the unpleasantness of a eutrophic lake, the policy maker will want to have that unpleasantness and the probability it will occur described as clearly as possible. In short, the policy maker seeks more science, not esoteric and subtle social indices and ways to monetize elusive values.

Second, intangible factors tend to be weighed by policy makers to

the degree that the factors have strong political and bureaucratic constituencies. Flood control, for example, is much studied and much heeded by policy makers partly because it is a politically salient issue. Floods, and politicians' responses to floods, are highly visible. The beneficiaries of a flood control program are well identified and often well organized. These include not only the flood plain inhabitants, but real estate groups, building trade unions, and other interests who would profit by the construction of flood control structures. Moreover, flood control has vigorous spokesmen in the Corps of Engineers, a strong and aggressive bureaucracy with ties to Congress and to many local interest groups. Factors, however intangible they may be, will be considered by analysts and weighed by policy makers if they are supported by a politically important constituency.

Third, a sense of "legitimate discourse" prevails in the relevant political community. For a variety of reasons, certain kinds of arguments or values cannot easily be conveyed or invoked. Thus politicians will be more likely to stress hard data (such as construction costs and tax benefits) than they will concepts such as beauty or solitude. In this sense, intangibles are at a disadvantage. To say that the Tocks project will flood a quiet and beautiful valley might open a politician to argument and derision—"who says the valley is beautiful?" To be sure, there is some circularity here. If enough people care about certain values, then it will be possible for politicians to discuss them. But the circularity is not complete; certain kinds of discourse invoking elusive and esthetic and elitist values do not seem to have equal standing in the political arena, a situation which often reinforces the prevailing political alignments. The values that appear most tainted are those that are nonquantifiable (beauty), are not associated with American self-confidence (skepticism toward economic growth), or are associated with esthetic minorities (quiet brooks).

Still other types of considerations appear to be off limits—possibly because they are too complex. For example, the Tocks project would attract considerable automobile traffic, a circumstance that would with statistical certainty increase markedly the number of traffic accidents on north New Jersey roads. It may or may not also cause a comparable reduction in traffic accidents elsewhere, but unless there is a perfect match in this increase and reduction, the effects are likely to be significant in any rational balancing of benefits and costs. Yet they are never considered.

Finally, the values of the decision makers, while not unalterable, form a crucial determinant of the weight they will give an intangible factor. In the field of social welfare, the allocation of funds (say)

between preschool education and cancer research will depend strongly on the deepest values of the decision makers; no contrived measure to compare benefits is likely to affect significantly this choice. How national security managers will weigh the various imponderables of risk, commitment, and honor will also ultimately depend on their values and their world view. Similarly, in the Tocks case, the policy makers typically have had strong intuitive ideas about the trade-off among various intangible benefits and costs—wilderness, flood control, social stability, and so forth.

V. CONCLUDING REMARKS

Even in principle, benefit-cost analysis cannot automatically make public choices for us. Because alternative policies will typically have important distributional effects in which some people will gain and others will lose, the decisions are intrinsically political, and they must be decided through the political process. The choices cannot be taken out of the political arena and made subject to the control and judgment of experts and bureaucrats. Political problems cannot be turned as if by magic into economic problems by waving a wand of benefit-cost analysis.

This is all the more true for analyses far from the ideal, such as those currently attained or attainable for projects of the complexity of Tocks. Combined with information about the distributional effects of alternative actions, however, benefit-cost analysis can usefully contribute to democratic decision making, by enhancing the ability of policy makers and citizens to predict the consequences of alternative policy actions. Unfortunately, the analysis too often conceals distributional effects and wraps the problem in a web of technical formulae and quantitative techniques that neither policy makers nor the public can penetrate. This permits the bureaucratic analysts to proceed undisturbed by the clamor of interest groups.

To become a component of genuine democratic decision making, and to improve significantly the reliability and completeness of predictions of consequences of alternative public choices, benefit-cost analysis must be executed in ways that encourage wider public participation in decision making; and to this end it must appropriate new styles of analysis and presentation that would make information more accessible and understandable to affected citizens and better clarify the consequences of the choices set before them. Rather than disguise the host of arbitrary assumptions and biases that necessarily inform any practical benefit-cost analysis, a proper study would clearly present differing approaches and divergent conclusions.

One cannot help but be distressed by the illusion of precision the

summary numbers in typical benefit-cost analyses present. At worst, these summary data are the resultant of a large number of possibly large errors; at best they will be merely clues about the consequences of a particular action. Instead of the crisp column of figures displayed in most benefit-cost analyses, perhaps what is needed is a sort of Rube Goldberg machine, with numbers popping out at odd times and places, to remind us of all the loose connections. A somewhat more modest suggestion (from editor Frank Sinden) is set forth below, as an appendix to this essay. It would be especially helpful to have various alternative plans and analyses drawn up for any project by competing agencies and interests who believe in them. The notion that a single agency such as the Corps can honestly set forward detailed analyses of alternative plans (most of which are not favored by the agency) seems unreasonable. The generation of many benefit-cost analyses by diverse groups might be disorderly, but it would almost certainly yield more comprehensive, more inventive and wiser results.

NOTES

1. The most recent listing is found in *The Federal Register*, vol. 38, no. 174, September 10, 1973.

2. Letter from Robert Jordan, III, Special Assistant to the Secretary of the Army, to Elmer B. Staats, Comptroller General of the United States, November 20, 1969. Reprinted in *Public Works, Hearings* before the Sub-Committee of the Committee of Appropriations, House of Representatives, Part I, 1971, p. 288.

3. This issue is discussed in greater length in D.F. Bradford, "Constraints on Public Action and Rules for Social Decision," *American Economic Review* LX (September 1970): 642–654.

4. On the problem mentioned, see, e.g., E.J. Mishan, "A Survey of Welfare Economics 1938–59," *Economic Journal* (1960), reprinted in E.J. Mishan, *Welfare Economics: Ten Introductory Essays*, 2nd ed. (N.Y.: Random House, 1969).

5. These issues are examined at greater length in D.F. Bradford, "Constraints on Public Action and Rules for Social Decision" *op. cit.*

6. The evaluation of recreation benefits is the subject of considerable literature. For some discussion of the literature, see the DRBC study #24-49-69, *Economic Studies of Outdoor Recreation*, "Economic Evaluation of Outdoor Recreation Benefits"; T.L. Burton and Margaret N. Fulcher, "Measurement of Recreation Benefits — A Survey," *Journal of Economic Studies* (July 1968): 35–48; Jack L. Knetsch and Robert K. Davis, "Comparisons of Methods for Recreation Evaluation," in *Water Research*, A. V. Kneese and S. Smith, eds. (Baltimore: Johns Hopkins Press, 1966).

7. See, for example, Alice Rivlin, *Systematic Thinking for Social Action* (Washington, D.C.: Brookings, 1971).

APPENDIX: ABOLISHING THE B/C RATIO

Benefit-cost analysis is widely regarded as a black box that produces a single number—the B/C ratio. It is as if a trial lawyer made his entire case with a single sentence: "From incontrovertible evidence I have deduced by impeccable logic that the defendant is guilty." No jury, of course, would accept that. It is the evidence and logic themselves that the jury wants to see. So it should be with benefit-cost analysis. The best way to deflect attention away from the B/C ratio would be to abolish it. This appendix outlines briefly a way of organizing a benefit-cost analysis and displaying its results without the aid of the ratio.

A benefit-cost analysis can be regarded as a list of additive components, each generating a stream of positive and negative benefits over time. The components can be displayed as follows:

			time →		
components ↓	construction	- - -	−$	−$	- - -
	power benefit	- - -	+$	+$	- - -
	flood benefit	- - -	+$	+$	- - -
	.		.	.	
	.		.	.	
	.		.	.	
	overall net benefit	- - -	Σ	Σ	- - -

No time horizon needs to be imposed; even distant events such as probable machinery replacements decades hence or siltation of a reservoir centuries hence can be indicated. Individual components can be further disaggregated in other renderings of the same format. The ultimate starting data or formulas should be measured relative to a precisely and explicitly defined base case.

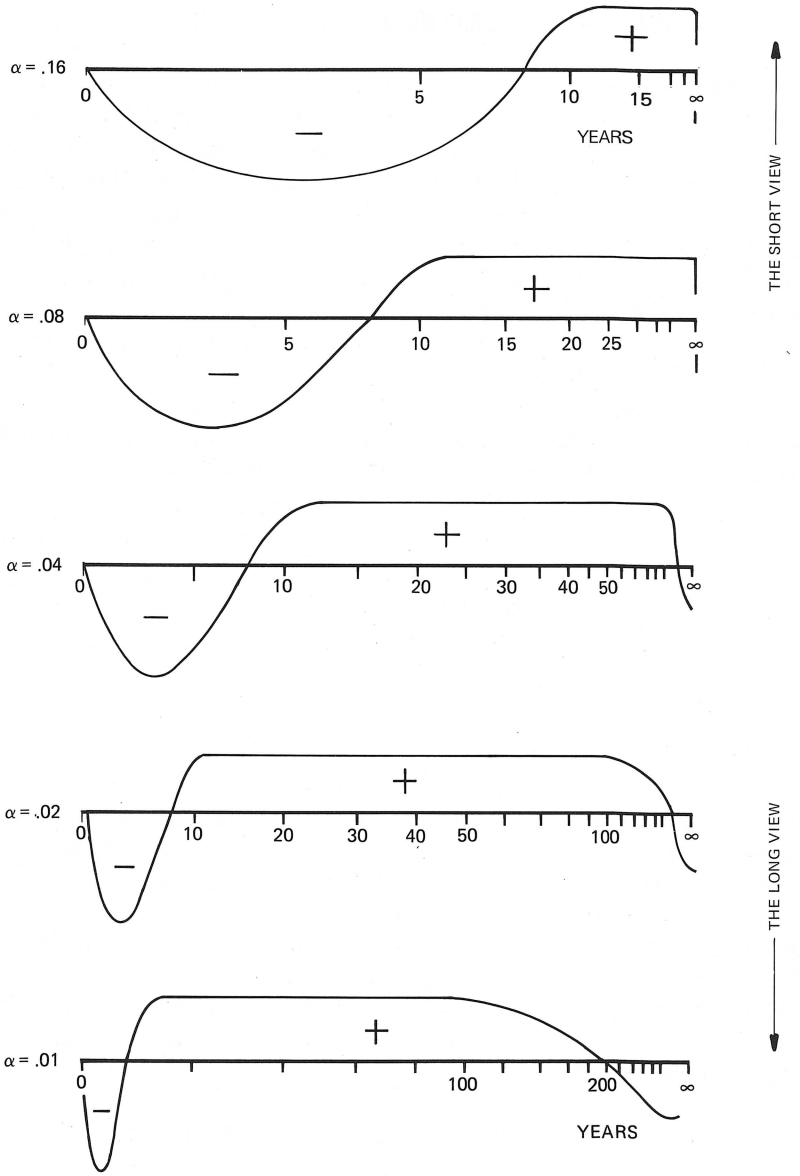
The output of the analysis is the bottom line of the final table, the overall net benefit function $B(t)$. This function can be summarized by the single number

$$\bar{B}_\alpha = \alpha \int_o^\infty B(t) e^{-\alpha t} dt = \text{"average annual net benefit"}$$

where α is the "discount rate."[i] This has the two drawbacks of creating a golden number and suppressing useful information.

I suggest instead that $B(t)$ not be summarized at all, but that it be plotted against a certain series of distorted time scales as shown in Figure 4-1. These scales (one for each discount rate α) are such that

[i] See Box 1, where a discrete form is given (p. 131).


α = .16
0
5
10
15
∞
YEARS
α = .08
0
5
10
15
20
25
∞
α = .04
0
10
20
30
40
50
∞
α = .02
0
10
20
30
40
50
100
∞
α = .01
0
100
200
∞
YEARS
THE SHORT VIEW
THE LONG VIEW

the net area under the curve (the area above the horizontal axis minus the area below it) is always just equal to $\overline{B}_\alpha$.[j] It is not difficult to judge this area roughly by eye. In most cases not much more precision than this would be justified anyway. In the example shown $\overline{B}_\alpha$ is positive for $\alpha \leqslant .04$, but not at the other values. The B/C ratio is simply the ratio of the positive area to the negative area. The graphs show intuitively what it means to take the short or long view. Note that the artificial idea of a "project life" is avoided: Events in the distant future simply do not show up in the short view graphs, yet they can always be made to appear by taking a sufficiently long view.

[j]For discount rate α, the semi-infinite t-axis is mapped onto the unit τ-interval by $\tau = 1 - e^{-\alpha t}$. Hence $d\tau = \alpha e^{-\alpha t} dt$.

Figure 4-1. The Same Hypothetical Net Benefit Stream Plotted on Different Time Scales. Construction lasts almost a decade, during which time money flow is negative (investment). Thereafter steady positive benefits are realized for a time. At about 100 years siltation begins to reduce the dam's effectiveness, and 150 years after that, the dam is completely useless, and since the river and valley are left in a less valuable state than if no dam had been built, a negative benefit is registered each year thereafter. Such distant future effects begin to show up on the right at very low discount rates. In the five cases shown, comparison of positive and negative areas shows the project to be uneconomic at $\alpha = .16$, marginal at $\alpha = .08$ and economic at $\alpha = .04, .02, .01$. At even lower discount rates, far below those conventionally considered, the project would again be uneconomic as the distant future effects take hold. Even though they profess to take a longer view of the future than most other people, Sierra Club members urge high discount rates and the Corps of Engineers urges low discount rates. It is easy to see why.