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Practiably Irrigable Acreage and Economic Feasibility: The Role of Time, Ethics, and Discounting

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I. INTRODUCTION

The "practicably irrigable acreage" criterion for quantifying water rights reserved for Indian tribes was established in *Arizona v. California*.[1] This case was reopened in 1980–81 for the purpose of adjudicating water for omitted and boundary lands of the several Indian tribes, and the Special Master's Report was submitted to the Supreme Court in February, 1982.[2] The 1982 Master's Report established an important precedent for measuring practicably irrigable acreage. The Master concluded: "For present purposes, a finding that annual benefits exceed costs will suffice for a finding of practicable irrigability."[3] Thus, practicably irrigable acreage is equated with "economic feasibility"[4] which is demonstrated generally by benefit-cost analyses wherein the ratio of benefits to costs is at least unity.[5]

The authors foresaw the potential relationship between economic feasibility and practicably irrigable acreage in a 1980 work that considered the historical characteristics of benefit-cost analyses.[6] Conclusions suggested in that work, however, were based on planning standards for benefit-cost analyses used prior to 1973. We gave little weight to the Water Resources Council's (WRC) 1973 Principles and Standards[7] for two reasons. First, we were concerned with the standards used during that period in which the bulk of western water development took place; few, if any, new large reclamation projects have been authorized by Congress since the late 1960s.[8] Second, the form of the WRC's final

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1. 373 U.S. 546, 601 (1963).
2. In the Supreme Court of the United States, October term, 1981, Arizona v. California, Report of Elbert P. Tuttle, Special Master, February 22, 1982 (hereinafter referred to as Master's Report 1982).
3. *Id.* at 100.
4. ". . . practicably irrigable . . . very nearly means 'economically feasible' . . . ," *id.; see also* 88–105.
5. This is equivalent to "annual benefits exceed cost."
6. Burness, Cummings, Gorman & Lansford, *U.S. Reclamation Policy and Indian Water Rights*, 20 NAT. RES. J. 807–26 (1980).
7. 38 Fed. Reg. 24,777 (1973).
8. *See, e.g.*, Interior Secretary Watt's observation, ". . . there are no ideal locations left for huge facilities, such as the Grand Coulee Dam . . . (for smaller reservoirs) as with other issues, the best has already been taken, whether it is a site for a dam or for a new national park." *We Can Protect Environment—And Bring On Development*, U.S. NEWS & WORLD REP., May 25, 1981, at 49, 50.

Principles and Standards was uncertain at that time.[9] Therefore, it must be understood that our 1980 paper does *not* provide ". . . a discussion of the economic theory aspects of the reclamation standards *such as those used in this case*" (emphasis added),[10] since 1973 guidelines were used in the "new" *Arizona v. California* case.[11] This disclaimer is intended to emphasize the difference in the structure of benefit-cost analyses using pre-1973 planning standards and those using the WRC's planning standards in effect between 1973 and 1982. With the demise of the WRC in 1982, "current" planning standards have yet to be fully defined.[12] In contrast to pre-1973 standards, the WRC's planning standards, which were used in studies presented to the U.S. Supreme Court in the "new" *Arizona v. California,* require that analyses be conducted under the assumption that the economy is fully employed. Implications of this assumption, as they relate to the scope of benefits and costs in a study of economic feasibility, are briefly described in a recent paper by the authors.[13]

Methods and standards for studies of economic feasibility change through time, and such changes may not be trivial.[14] More is involved than which methods/standards are most relevant for Indian water rights law. If one is to use benefit-cost measures for economic feasibility to demonstrate practicably irrigable acreage, one must understand what a benefit-cost study measures and what it does not measure. Given the implications of the practicably irrigable acreage criterion established in law, one must ask what kind of an economic feasibility measure—as determined by planning methods/standards used—is appropriate or consistent with this practicably irrigable acreage rule.

The purpose of this paper is to examine the legal and economic implications of using the economic concept of feasibility as a basis for quantifying practicably irrigable acreage. Specifically, we will consider the role of time and ethics in benefit-cost studies and their relationship to the practicably irrigable acreage criterion for quantifying Indian water rights.

The primary concerns of this paper are the critical assumptions and rationale underlying studies used to develop measures for economic feasibility. These issues are central to an understanding of at least one dimension of the relationship between economics and the law. Notions of equity and fairness are basic to law; the practicably irrigable acreage rule

9. 45 Fed. Reg. 64,366 (1980).

10. Master's Report 1982, *supra* note 1, at 97, n. 17. *See also* notes 17, 27.

11. Master's Report 1982, *supra* note 1.

12. 47 Fed. Reg. 12,296 (1982).

13. Burness, Cummings, Gorman & Lansford, *The 'New' Arizona v. California: Practicably Irrigable Acreage and Economic Feasibility,* 22 NAT. RES. J. 517–23 (1982).

14. *Id., see* Section III.

may be seen as an effort by the court to distribute water rights on the basis of fairness and equity. Generally, however, equity and fairness are not fundamental issues per se in economics. Economics is concerned with efficiency: given a distribution of income (or a means to create income such as water rights), irrespective of the "fairness" of this distribution, economics is concerned with deriving the highest valued production of goods and services from this given distribution of resources. Thus, a number of structural assumptions underlie any measure of economic feasibility; changes in these assumptions will result in changes in the measures of economic feasibility. Most importantly, these assumptions reflect one's judgment as to what is fair or equitable. If the law is to use economic measures for its ends, the courts must clearly understand the equity implications of alternative structures (assumptions used) for economic analyses. The courts must do what the economist cannot: determine the structure of economic feasibility analyses that squares most closely with the courts' concern with fairness and equity. The intent of the authors is to clarify structure-equity implications in benefit-cost studies.

II. TIME IN BENEFIT-COST STUDIES

Time has importance in two dimensions when benefit-cost studies are used to demonstrate practicably irrigable acreage. The first dimension concerns planning standards, which have historically changed through time. Since this issue is discussed elsewhere,[15] it will not be examined here. The second dimension of time relates to an understanding of the purposes which benefit-cost studies are intended to serve.

Benefit-cost analyses were implemented in the assessment of water reclamation in response to Congressional mandates during the 1930s.[16] The benefit-cost method was structured to address the question: "Is a proposed project economically feasible?"[17] A project was deemed feasible when benefits and costs, "to whomsoever they may accrue," and "based on current planning standards and objectives," result in a benefit-cost ratio greater than one.[18] One must note, however, that such a benefit-cost measure is based on economic conditions (planning standards/objectives, energy costs, the cost of capital, general fiscal policies, and so forth) prevailing at that particular time. Thus, if we measure benefits and costs for a project today and it is not feasible, it is not built. In rejecting

15. *Id.*

16. *See* Burness, *supra* note 6, § II. *See* Little & Mirrlees, *Social Cost-Benefit Analysis, Organization for Economic Cooperation and Development*, 2 MANUAL OF INDUSTRIAL PROJECT ANALYSIS 30 (1969).

17. In addition to works cited *id.*, *see* Howe, *Benefit Cost Analysis for Water Systems Planning*, 2 WATER RESOURCES MONOGRAPH (American Geophysical Union) (1971).

18. Flood Control Act of June 22, 1936, Ch. 688, § 2, 49 Stat. 1570.

the project that is infeasible "today," however, nothing is lost vis-à-vis the future. In any future year, as planning standards/objectives change and/or as general economic conditions change, we can again examine the feasibility of the project. If, at that later date, the project is found to be feasible, it may then be built.

On the other hand, suppose that in evaluating benefits and costs of a project, we are told that our assessment of the project precludes any future assessment of the project. The project is built "today" or never. What guidelines do we then follow when preparing a measure for economic feasibility in this context? While there are some questions concerning the appropriate uses of benefit-cost analysis for addressing such once-and-for-all questions,[19] common practice for evaluating projects which involve irreversible, once-and-for-all effects is to consider the value of *all* options to *all* future generations that would be foregone if the project were or were not built.[20] Such values are then included as benefits or costs for the project in question.

These discussions suggest the following line of argument. Benefit-cost analysis is designed to assess the economic feasibility of a project which has a well-defined and finite lifetime; at issue is the question: are expenditures of public funds on this project economically feasible? However, the practicably irrigable acreage criterion concerns a water right, and such rights are timeless. Indeed, the courts emphasize the role of such rights in satisfying future needs of the tribes: ". . . the water was intended to satisfy the future as well as the present needs of the Indian Reservations. . . ."[21] Adapting the benefit-cost method to reflect potential impacts of a project on distant generations involves a great deal of speculation about the nature of these future impacts. Aside from related technical difficulties, the courts have seemingly rejected such speculation.[22] Under these conditions, one may ask how closely economic feasibility measures, based on benefit-cost analyses of a time-specific project, adhere to the intent of the law concerning water rights which are essentially timeless in nature and intended, in part, to satisfy needs of distant generations.

In addition to the role of time, in terms of the distinction between projects and rights, economic feasibility measures drawn from benefit-cost studies have ethical implications. We now turn our attention to this topic.

19. Indeed, as is discussed below, serious ethical questions arise as to the appropriateness of using benefit-cost analyses when long-term, irreversible consequences are involved.

20. For a loose analogy in this regard, *see* Fisher, *The Economics of Environmental Preservation: A Theoretical and Empirical Analysis*, 62 AM. ECON. REV. 605 (1972)

21. 373 U.S. 546, at 600.

22. *See id.*, "How many Indians there will be and what their future needs will be can only be guessed."

III. ETHICS AND DISCOUNTING IN BENEFIT-COST STUDIES: THE ISSUE OF INTERGENERATIONAL EQUITY

In this and the following section, we consider the development of benefit-cost measures of economic feasibility when such measures are to reflect a legal principle requiring the satisfaction of future as well as present needs. The importance of future needs relative to present needs is the major concern; i.e., is the satisfaction of future needs to be "weighed" differently (discounted) than the satisfaction of present needs? In addressing these issues, we must look at two sets of questions. In this section, we ask: What is the rationale for the discounting of future benefits and is this rationale appropriate for the practicably irrigable acreage rule? In Section IV, we deal with the *choice* of an "appropriate" discount rate.

The rationale for discounting in the private sector is reasonably straightforward; discounting is a mechanism for comparing cash flows (through time) from alternative investments. As an example, consider a businessman facing two alternative ways for investing $1,000. Investment 1 yields a return of $2,000 to be received at the end of five years; Investment 2 yields $2,500 which is received at the end of 10 years. To evaluate these returns which are received at different points in time, the businessman can calculate, and compare, the present value of these future returns. The present value of $2,000 received after five years is the amount of money which, if invested today at *r* percent interest for five years, would be worth $2,000 at the end of five years. Thus, the discounted present value of a future return is today's monetary equivalent of the future return. If the interest (discount) rate is, e.g., 5 percent, the present value of Investment 1's $2,000 return is $1,567; similarly, at 5 percent, the present value of Investment 2's $2,500 is $1,534.[23] Thus, Investment 1 is preferred to Investment 2 despite the latter's larger pure cash return. Note that at a lower discount rate, e.g., 2.5 percent, the present value of Investment 1's return is $1,768, less than the present value of Investment 2's return of $1,952, and Investment 2 is then preferred. In general, the higher (lower) the discount rate, the less (more) attractive are future returns.

The rationale for discounting in benefit-cost analyses is not as immediately obvious as in the businessman's case. In analyses of public projects, the counterpart to the businessman's future cash returns is net social benefits. The substance of future flows of social benefits is the future value of society's consumption of goods and services; these values are

23. The formula is $PV = R\left(\frac{1}{1+r}\right)^t$, where PV = present value, R_t = return in year t, r = rate of discount (interest), and t = number of years before the return is received.

usually approximated by measures of market values.[24] As evidenced above, the effect of discounting is to diminish the importance of more distant returns relative to more proximate returns. The question then becomes: Why should the federal government weigh society's future consumption, e.g., 20 or 200 years in the future, differently from society's consumption of goods and services today? If some compelling reason exists for treating future consumption differently from present consumption, a corollary question becomes: Should the government follow the same rules as a financial manager, whose goal (in a risk-free world) is to maximize profits over a relatively short horizon, or should the government follow a different set of rules?

The above question about the rationale for the government's discounting of the future value of society's consumption has at least three responses. The first response centers on the opportunity cost of funds required to build the particular project; that is, if funds used to finance the project displace private (or other public) investments, which themselves give rise to future flows of consumption, social benefits from the project should be at least as great as those that would result from displaced projects. If r_c measures the productivity of capital investments at the margin,[25] in terms of capital's generation of future consumption goods, the project should provide a flow of benefits at the rate r_c if it is to be at least as "productive" as the investments that it displaces; equivalently, future benefits from the project should be discounted at the rate r_c to reflect the benefits foregone from displaced investments.

A second response focuses on society's preference for present consumption rather than future consumption. All else equal, individuals are assumed to prefer consumption "today" to consumption in the future. Therefore, one must be paid a premium to postpone present consumption. This premium is reflected by the individual's subjective rate of time preference or the consumption rate of interest, r_t. Thus, this rationale for the government's discounting of future social benefits at the rate r_t relies on the assumption that society per se views future consumption differently from present consumption, that future consumption is in some sense less valuable and, therefore, is discounted at the rate r_t.

The third response to the question as to why the government might discount future benefits casts the question in the context of ethics.[26] First,

24. *See* Herberger, *Three Basic Postulates for Applied Welfare Economics,* 9 J. ECON. LIT. 785 (1971).

25. The "marginal" investment is relevant in this regard inasmuch as the displaced investment must necessarily be the "last"—in order of productivity—investment that might be undertaken. Thus, r_c, as a measure of the *marginal* productivity of capital, will be *less than* the average productivity of capital in the economy. This point is stressed in any basic textbook in economics.

26. The following discussion draws on the following works: Schulze, Brookshire & Sandler, *The Social Rate of Discount for Nuclear Waste Storage: Economics or Ethics?* 21 NAT. RES. J. 811–31

we must distinguish between a project or action wherein associated benefits and/or costs accrue over 100 years (usually) and a project or action wherein benefits and/or costs accrue across many future generations.[27] For projects/actions of the latter type—wherein many future generations are impacted—one can argue that treatment of future generations depends on the ethical beliefs of society as they relate to future generations.[28] "Discount rates are determined solely by the ethical criteria employed in the analysis."[29]

An ethical system, of course, provides rules for judging actions to be "right" or "wrong." Examples include a utilitarian system: "The greatest good for the greatest number"; an elitist system: "The greatest good for the most well-off"; and a libertarian system: "Individual freedoms prevail except when others may be harmed."[30] After considering these ethical systems, the studies cited above[31] conclude that discounting is inappropriate in benefit-cost analyses of projects affecting future generations.[32] "Decisions based on discounting are unethical."[33] Consequently, a zero or "low" rate of discount in the range of 0 to 2½ percent is recommended,[34] e.g., "a zero rate of discount . . . may be the most tenable assumption for economic analysis depending on the ethical criterion used in the analysis."[35]

The ethics argument described above has been developed as a means of evaluating environmental risk associated with such things as nuclear waste storage and CO_2 accumulations in the earth's atmosphere. Thus, for example, benefits associated with a nuclear waste disposal project may involve risk to public health and safety associated with the project where such risk may extend over thousands of years. At issue are the ethical implications of discounting those health damages that may occur

(1981) (hereinafter referred to as Ethics-1); d'Arge, *Benefit-Cost Valuation of Long-Term Future Effects: The Case of CO_2*, Workshop on the Methodology for Impact Analysis of Climate Change, Ft. Lauderdale, Florida, April 1980 and Department of Economics, University of Wyoming (hereinafter referred to as Ethics-2); Schulze, *Intergenerational Ethics and the Depletion of Fossil Fuels*, in COAL MODELS AND THEIR USE IN GOVERNMENT PLANNING Chap. 10 (J. Quirk, ed. 1982) (hereinafter referred to as Ethics-3); Ben-David, *A Study of the Ethical Foundations of Benefit-Cost Analysis Techniques*, Working paper, Program in Resource Economics, University of New Mexico, August 1979 (hereinafter referred to as Ethics-4); Kneese, *Long-Term Nuclear Waste Storage: An Economic and Ethical Perspective*, Working paper, Department of Economics, University of Wyoming, Laramie (hereinafter referred to as Ethics-5).

27. Ethics-1, *id.*, at 1.
28. Ethics-2, *supra* note 26, at 1.
29. Ethics-3, *supra* note 26, at 176.
30. Ethics-3, *id.* at 165, and Ethics-1, *supra* note 26.
31. *See generally, supra* note 26.
32. Ethics-2, *supra* note 26, at 12, and Ethics-5, *supra* note 26, at 1.
33. Ethics-2, *supra* note 26, at 12.
34. Ethics-1, *supra* note 26, at 814; Ethics-4, *supra* note 26, at 33; and Ethics-5, *supra* note 26, at 1.
35. Ethics-1, *supra* note 26, at 814.

TABLE 1

Importance of Future Generations Relative to the Current Generation

Discount Rate	1 (25 years)	2 (50 years)	3 (75 years)	4 (100 years)
		(percent)		
0	100	100	100	100
1	72.98	60.80	47.41	36.97
2	60.95	37.15	22.65	13.80
4	37.51	14.07	5.28	1.98
7	8.42	3.39	0.63	0.12
10	9.23	0.85	0.08	0.01

in a thousand years; for example, $1 billion in health damages after a thousand years, if discounted at 4 percent, would be valued today at $9.26. The ethical implications of treating $1 billion in costs to be borne by a future generation as worth $9.26 are obvious.

Even in the context of shorter time horizons, discounting has significant effects on future generations. For example, a $10,000 benefit to be received 100 years or four generations hence has a present value of $198 when discounted at 4 percent. Each subsequent generation is weighted by a factor that is the result of discounting at 4 percent over an additional 25 years. For the next four generations after the current generation, these factors are .3751, .1407, .0528, and .0198, respectively. Thus, subsequent generations' needs and satisfactions are only 37, 14, 5, and 2 percent, respectively, as important as those of the current generation. The effects of different discount rates are set out in Table 1.

It has been suggested that the arguments considered above do not apply to the practicably irrigable acreage rule inasmuch as water development projects, with finite use lives, are used as a vehicle to demonstrate practicably irrigable acreage.[36] However, the relevant fact is that economic feasibility analyses of such projects in Indian water rights cases are undertaken in order to quantify a water right that extends into perpetuity, not just over the finite life of the associated irrigation project. Thus, it would seem that the ethics argument cannot be rejected strictly on the grounds that water development projects are the analytical vehicles used to demonstrate irrigable acreage.

36. In particular, *see* the testimony of Prof. David Brookshire in the District Court for the Fifth Judicial District, Washakie County, State of Wyoming, In Re: The general adjudication of all rights to use water in the Big Horn River System and all other sources, Civil No. 4993, testimony before the Special Master (hereinafter cited as Fifth Judicial District); Vol. 157, afternoon session, Monday, December 14, 1981; *see* particularly 14568–14595 and 14569–70.

Moreover, the writers cited above[37] conclude that discounting is unethical in circumstances where project effects on future generations involve effects on life/health,[38] lifestyles,[39] technologies,[40] and options ("maneuverability").[41] Thus, the relevance of the "ethics" argument, which suggests that there is no rationale for the government's discounting of social benefits and costs, turns on one's interpretation of the "provide for future needs" dimension of the court's practicably irrigable acreage criterion. The question is whether the court's intent is better represented by the standard "straightforward" 100-year project or by the intergenerational continuum of effects on life, lifestyles, and so forth.[42]

To summarize the above, those in the economics profession have reached no consensus on the appropriate rationale for discounting in the analysis of public projects. Similarly, inquiries to determine an appropriate rationale for discounting in quantifying practicably irrigable acreage result in different conclusions. The Court must look to that rationale for discounting which most nearly adheres to the law: are measures for satisfying future needs of the Indians of equal or different weight than measures for satisfying present needs; are reserved rights equated with a (relatively) short-lived project or do they extend into perpetuity?

IV. RATIONALE FOR THE CHOICE OF A DISCOUNT RATE

The choice of an "appropriate" discount rate depends in large part on one's view of the rationale for discounting. If one accepts the ethics position, the choice of a discount rate is reasonably straightforward: it is zero or low, in the range of 0 to 2½ percent.

Before examining ways of acquiring an investment or consumption rate of interest, we must clarify one point. In preparing a benefit-cost study, one typically ignores price inflation likely to occur in the future. "Current" prices are used to value all future benefits and costs for several reasons. Few would agree on estimates of inflation rates of 20, 50, and 100 years in the future; even the most sanguine of economic forecasters would reject this task. Second, still another large area of uncertainty would be introduced into the analysis. When values are expressed in "constant" dollars indexed to some base year, these values, or prices, are called "real" (inflation-free) prices, in contrast to current, nominal

37. *Supra*, note 26.
38. Ethics-1, *supra* note 26; Brookshire testimony, *supra* note 36.
39. Ethics-2, *supra* note 26, at 1; Ethics-3, *supra* note 26, at 1.
40. Ethics-2, *supra* note 26, at 1.
41. Ethics-1, *supra* note 26, at 22.
42. Interestingly, referring to effects on life, the Special Master observes: "I would like to make it . . . (clear) . . . that we are dealing with life when we are dealing with water in Wyoming," Fifth Judicial District, *supra* note 36, at 14576.

prices. If one uses real prices, one must then use a real (inflation-free) discount rate. Consider the following example:

Suppose that you make a loan of $10 today and that, at today's prices, you can buy widgets (the only commodity that is of value to you) at $1 per widget. Suppose further that you require repayment in real (today's) prices and that your time preference for consumption (the return required if you are to postpone consumption) is 2 percent. Thus, the repayment that you require after one year is 10.2 widgets, or $10.20 at today's prices. Your repayment, $10.20, when discounted with your 2 percent consumption rate of interest, equals your original loan of $10.[43] Let the expected inflation rate for the upcoming year be 10 percent. The borrower must then be prepared to pay $11.20 at the end of the year in order to make the real repayment of 10.2 widgets; with the future nominal price of widgets at $1.10 ($1 inflated by 10 percent), the nominal interest rate must be 12 percent—your "real" 2 percent consumption rate plus 10 percent inflation. Note that the repayment of $11.20, when discounted at 12 percent, equals your original loan of $10 ($11.20 ÷ 1.12).

The point to be derived from this example is the following. If constant prices are used, one uses the real (inflation-free) discount rate ($10.20 ÷ 1.02 = $10). The use of a nominal discount rate (12 percent) with real prices ($10.20) understates the present value of the future return ($10.20 ÷ 1.12 = $9.11, rather than $10); only when future (including inflation) prices ($11.20) are used, should one use a nominal discount rate ($11.20 ÷ 1.12 = $10).[44] As benefit-cost studies typically employ constant prices, then real values for discount rates should be used.

We now consider the manner for choosing an "appropriate," real discount rate consistent with rationale for investment rates of interest and consumption rates of interest. The first issue is the consumption rate of interest, wherein we examine society's preference for present consumption over future consumption. We look at individual behavior with respect to past trade-offs between present and future consumption; i.e., we examine real rates of return which, historically, have been sufficient to induce individuals to postpone current consumption. In this regard, nominal and real rates of return are given in Table 2 for three common types of investments: long-term government securities, high-grade municipal bonds, and preferred stocks.[45] All else equal, stocks are "riskier" and

43. $112.20 ÷ (1.02 × 1.10) = $100.

44. In the example above, the nominal rate of interest is 12.2 percent. The real interest rate is (1.122 ÷ 1.10) − 1 = .02, or 2 percent.

45. Conspicuous by their absence are returns from savings deposits which have, until recent times, been extraordinarily low, yielding, in most years, *negative* real returns. Their exclusion reflects the fact that such rates were regulated by the federal government until recently. Notwithstanding federal regulation, low real returns on savings deposits reflect the fact that the real consumption rate of interest for many individuals has been low if not negative.

TABLE 2

Historical Nominal and Real Rates of Return for Alternative Investments

	U.S. Gov. Securities 3–5 years (3 years, 1973–80)		High Grade Municipal Bonds		Yields on Preferred Stocks	
	Current[1]	Real[5]	Current[3]	Real[5]	Current[4]	Real[5]
1940	0.73%[2]	0.13%	2.50%	1.90%	4.14%	3.54%
1945	1.18	0.50	1.67	1.07	3.70	3.10
1950	1.50	0.70	1.98	1.18	3.85	3.05
1955	2.50	1.70	2.53	1.73	4.01	3.21
1960	3.99	2.29	3.73	2.03	4.75	3.05
1965	4.22	2.02	3.27	1.07	4.33	2.13
1970	7.37	1.92	6.51	1.11	7.22	1.82
1973	6.95	1.15	5.18	0.38	7.23	1.43
1974	7.82	−1.88	6.09	−3.61	8.24	−1.46
1975	7.49	−2.11	6.89	−2.71	8.36	−1.24
1976	6.77	2.57	6.49	1.29	7.98	2.78
1977	6.69	0.69	5.56	−0.44	7.61	1.61
1978	8.29	0.99	5.90	−1.40	8.25	0.95
1979	9.71	0.91	6.39	−2.41	9.11	0.31

[1]U.S. DEPT. OF COMMERCE, HISTORICAL STATISTICS OF THE U.S., COLONIAL TIMES TO 1970 1001 (1975) (hereinafter cited as HISTORICAL STATISTICS). STATISTICAL ABSTRACT OF THE U.S., 1973–82, Table 907, p. 545.
[2]Data for 1941.
[3]HISTORICAL STATISTICS, *supra* item 1 at 1003. For 1973–1980, *see* STATISTICAL ABSTRACT , *supra* item 1, Table 907 at 545.
[4]*Id.*
[5]Adjusted for inflation rates given in Table 3.

returns are taxable, ergo the (generally) higher return on such investments; interest on municipal bonds is tax-free, thus their (generally) lower return vis-à-vis government securities. Some argue that the "appropriate" discount rate for public projects is one which includes premiums for risk and taxes.[46] While this view is not universally accepted,[47] data in Table 2 for stocks would suggest an upper bound for a real consumption rate of interest, a rate of 3.54 percent.

One may find the real rates of return in Table 2 surprisingly low, particularly in view of recent monetary conditions wherein certificates of deposit have yielded 15 percent or more. Recall, however, the high inflation rates in 1979 and 1980, which resulted in low real rates of return, as well as the role of expected inflation rates in the determination of nominal returns (see Table 3).[48] Of course, the appeal of using long-run,

46. *See*, particularly, Banmol, *On the Social Rate of Discount*, 58 AM. ECON. REV. 4 (1968).
47. *See* O. Herfindahl & A. Kneese, ECONOMIC THEORY OF NATURAL RESOURCES 204–21 (1974).
48. Indices in Table 3 are from the GNP deflator; the consumer price index rose 11.3 percent and 14.4 percent in 1979 and 1980, respectively; *see Statistical Abstract*, *supra* Table 3, note 1, Table 807.

TABLE 3

Historical Rates of Inflation

Year	Rate of Inflation[1]
1940	0.6%
1945	0.6
1950	0.8
1955	0.8
1960	1.7
1965	2.2
1970	5.4
1973	5.8
1974	9.7
1975	9.6
1976	5.2
1977	6.0
1978	7.3
1979	8.8
1980	9.2

[1]HISTORICAL STATISTICS, *supra* Table 2, item 1, at 198. GNP price deflator, increase from previous year; column 19, deflator for total sectors (1958 = 100), for 1940–55. For 1960–80, STATISTICAL ABSTRACT, *supra* Table 2, item 1, Table 794 at 478.

historical averages for measures of value lies in "smoothing across" short-run anomalies; recent conditions are relevant only if one expects a sustained break with past trends and a continuation of present conditions. While the issue is obviously debatable, recent conditions appear to be anomalous, and the use of long-run averages would seem to be appropriate. Thus, to reflect real rates of return which measure de facto societal trade-offs between present and future consumption, one would choose a rate up to 3.54 percent as a real consumption rate of interest.

Looking next to the investment-displacement (as opposed to consumption-displacement) rationale for a social discount rate, the investment rate of interest must reflect the real marginal productivity of investments (or capital) in the economy. While the marginal productivity of capital is our desired measure, good data for such measures are not available. Availability of data dictates the use of measures for the average productivity of capital as a proxy for marginal measures; one must understand that average returns are higher than marginal returns.[49] Thus, average measures will result in over estimates for the investment rate of interest.

49. *See* note 24 *supra;* this point is developed in any basic textbook in economics; *see, e.g.*, HERFINDAHL & KNEESE, *supra* note 47, at ch. 1.

Average nominal and real rates of return to capital in 46 sectors of the U.S. economy for the period 1948–76 are given in Table 4. The weighted average for all sectors during this period was 4.78 percent.[50] Analogous to the above argument concerning averages over time, the use of a weighted average (4.78 percent) over economic sectors is employed as representative of the average productivity of capital to "smooth over" sectoral differences in rates of returns which change through time. For example, one may compare the 24.5 percent historical real return for the automobile industry reported in Table 4 with current low returns in that industry.

In summary, one's choice of a discount rate depends upon one's judgment as to the "appropriate" rationale for discounting. The "ethics" argument may lead one to choose zero, or very low discount rates. Consumption and investment displacement arguments may lead to rates of approximately 0 to 3.5 percent and 4 to 5 percent, respectively.

V. CONCLUSION

The quantification of water rights as reserved for Indian tribes as established in *Winters* and *Arizona v. California* has been plagued with ambiguities as to the operational definition of "practicably irrigable acreage." The Court's adoption of economic feasibility, indicated by a benefit-cost ratio greater than (or equal to) unity, as a means for demonstrating practicably irrigable acreage may be viewed as one step towards removal of some of these ambiguities. In this and an earlier paper,[51] however, we have attempted to identify ambiguities associated with the definition of "economic feasibility." Our major point is that there is no single, objective measure for economic feasibility. Results from a benefit-cost study may be very sensitive to underlying assumptions. Most importantly, these assumptions are important due to their implications vis-à-vis the Court's intent in establishing the practicably irrigable acreage rule. We conclude this paper with a summary of the more important assumptions.

(a) *Time*. For two reasons the manner in which time is treated in a benefit-cost analysis can be of critical importance in quantifying practicably irrigable acreage. First, planning standards change through time. Benefit-cost measures used to assess the economic feasibility of water reclamation projects with pre-1973 standards were almost double those benefit-cost measures derived using standards that existed between 1973 and 1982.[52] Second, benefit-cost analysis was not specifically developed for "irreversible" types of decisions such as those involving the quan-

50. Fraumeni, *Rates of Return by Industrial Sector in the U.S.*, 70 AM. ECON. REV. 326, 328 (1980).
51. Burness, *supra* note 16.
52. *Id.*

TABLE 4

Average Nominal and Own (Real) Rates of Return in Economic Sectors, 1948–76

Industry Sector	Nominal	Own (Real)
Agriculture	7.49%	3.50%
Agricultural Services	6.93	3.88
Metal Mining	9.00	4.62
Coal Mining	14.24	10.21
Crude Petroleum	12.40	8.12
Nonmetallurgical Mining	15.22	11.35
Construction	14.71	10.78
Food	10.31	6.67
Tobacco	13.50	10.85
Textiles	9.03	5.77
Apparel	10.52	8.09
Paper	12.83	8.64
Printing & Publishing	10.69	6.54
Chemicals	13.22	9.50
Petroleum Refining	12.40	8.12
Rubber	10.52	6.60
Leather	9.80	7.24
Lumber & Wood	20.45	16.48
Furniture	11.37	7.41
Stone, Clay, & Glass	11.23	7.38
Primary Metal	9.00	4.62
Fabricated Metal	10.51	5.95
Machinery (Excluding Electrical)	14.60	10.68
Electrical Machinery	12.12	8.25
Transportation Equipment	5.35	1.27
Motor Vehicles	28.46	24.50
Professional Photographic Equipment	14.20	10.52
Miscellaneous Manufacturing	13.82	10.30
Railroads	7.47	3.46
Street Rail, Bus	17.12	13.52
Trucking Services	14.35	10.31
Water Transportation	7.27	4.55
Air Transportation	1.99	1.52
Pipelines	11.06	6.97
Transportation Services	9.83	6.32
Telephone & Telegraph	14.60	11.26
Radio & Television	15.14	11.88
Electric Utilities	13.06	8.36
Gas Utilities	14.54	9.88
Water	18.24	13.99
Wholesale Trade	12.69	9.36
Retail Trade	10.17	6.77
Finance, Insurance, & Real Estate	5.60	1.78
Services	9.13	5.33
Households	7.93	4.42
Institutions	7.93	3.09
Weighted Average, All Sectors		4.78

Source: Fraumeni & Jorgenson. *Rates of Return by Industrial Sector in the U.S., 1948–76*, 70 AM. ECON. REV., 326, 327 (1980).

tification of water rights. Adjustments in "normal" methods for such analyses would be required if benefit-cost measures are to reflect, within an intergenerational context, the "future needs" aspects of the practicably irrigable acreage criterion.

(b) *Rationale for Discounting.* A major problem is determining a rationale for discounting that appropriately fulfills the Court's intent in setting out the practicably irrigable rule. At issue is whether satisfaction of future needs by the Indians should be weighed differently from the satisfaction of current needs and just what "future" means. If "future needs" relates to several future generations, the intergenerational equity position may have appeal, in which case a zero or low discount rate may be appropriate. If not, the Court's intent must be squared in some way with the investment displacement rationale and/or the consumption displacement rationale for discounting.

Given a rationale for discounting, a real, inflation-free discount rate must be chosen. As noted above, a zero or very low rate may be appropriate when the intergenerational ethics rationale is accepted. Focus on the consumption displacement rationale implies a real rate in a range up to 3.5 percent. Finally, reliance on the investment-displacement rationale would imply a real discount rate of approximately 4 to 5 percent.