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THE GRAND CANYON CONTROVERSY:  
LESSONS FOR FEDERAL COST-BENEFIT PRACTICES

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Over the last decade the economics profession has devoted considerable energy to suggesting practical procedures for improving the evaluation of water resource projects.<sup>1</sup> It would be difficult, however, to find any area of public policy in which the profession's recommendations have been so nearly unanimous or met so little acceptance in practice. Few cases provide a better illustration of how little change has occurred than the bitter controversy that has raged during both the 89th and 90th Congresses over the construction of two dams in the Grand Canyon. This probably represents the first time that a Federal water resource agency has had to make a serious public defense of its economic justification for a major project prior to its authorization as the result of an attack based on the improved procedures recommended by the profession.

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The latest round of the Grand Canyon controversy provides ample material concerning the deficiencies of the economic criteria currently used by Federal water resource agencies. Although there have previously been some general comments on the shortcomings of the current criteria,<sup>2</sup> the exchanges generated by this controversy have served both to emphasize some of the operationally more important differences between current practices and accepted economic principles that have already been brought out in the literature and to point out some other differences not previously reported. It is the purpose of this article to review and analyze these extensive exchanges to pick out some of the more important differences in both categories.

Although the controversy over the dams led to an active search for alternatives to these particular dams by the United States Department of the Interior, a reversal of the Administration's stand on the dams, and even to expressions by the Department's leadership of a desire to examine alternatives to all projects in the future before they are submitted to Congress,<sup>3</sup> there is little indication that the Administration plans the major overhaul of the economic criteria and project review procedures that would be required to insure that the future development of water resources would be more in accord with economic principles.

BACKGROUND

The Grand Canyon controversy arose because of the proposal to build two dams in the Canyon as part of the proposed Colorado River Basin Project, one in Marble Gorge and the other in Bridge Canyon. Bridge Canyon Dam (now to be called Hualapai Dam as part of an agreement made with the Indian tribe of the same name) would be located 53 miles downstream from Grand Canyon National Monument while Marble Canyon Dam would be 12.5 miles above the boundary of Grand Canyon National Park. Backed by seven Southwestern states during the 89th Congress, the Project was opposed primarily by conservationists (particularly the Sierra Club) and the Pacific Northwest.<sup>4</sup>

The publicly stated purpose of the dams was to provide revenue to subsidize the Central Arizona Project (CAP) to bring Colorado River water to the Phoenix-Tucson area from the existing Lake Havasu impounded by Parker Dam. In May 1966, however, it was shown (and admitted with certain reservations by the United States Bureau of Reclamation<sup>5</sup>) that the dams were not needed to finance the CAP at all,<sup>6</sup> and that their real but little publicized purpose was to build a fund for the possible future importation of water into the Colorado River<sup>7</sup> (presumably from the Columbia River) if and when this should prove to be politically and economically feasible.

After the Colorado River Basin Project died in the House Rules Committee at the end of the 89th Congress, Secretary of the Interior Stewart Udall directed the Bureau of Reclamation to study nuclear and other alternatives to the dams. On February 1, 1967, he announced a revised Administration plan for the development of the Lower Colorado that no longer included either of the Grand Canyon dams. Under this

plan power needs of the Central Arizona Project were to be met from a steam plant. A bill including this proposal was passed by the Senate in August 1967, at which time an amendment to add Hualapai Dam was defeated by a vote of 70 to 12.

Briefly stated, the economic controversy over the Projects arose largely as a result of a 1966 study<sup>8</sup> by William E. Hoehn and the author that concluded that the benefit-cost ratio for Marble Canyon Dam is less than one-to-one when compared with nuclear alternatives. A subsequent study reached the same conclusion for both projects.<sup>9</sup> The differences between the most recent estimates are shown in Table 1.

Table 1  
BENEFIT-COST RATIOS ESTIMATED FOR  
GRAND CANYON DAMS  
(ratio to one)

Dam	Interest Rate (per cent)	Bureau of Reclamation	Carlín - Hoehn	
		3	3-1/8	5
Bridge Canyon (Hualapai)		2.0 <sup>a</sup>	0.61 <sup>b</sup>	0.52 <sup>b</sup>
Marble Canyon		1.7 <sup>c</sup>	0.76 <sup>d</sup>	0.61 <sup>d</sup>

<sup>a</sup>United States Department of the Interior, Bureau of Reclamation, Pacific Southwest Water Plan, Supplemental Information Report on Eridge Canyon Project, Arizona, January 1964, p. 22.

<sup>b</sup>Based on use of nuclear plant and fuel costs as of late 1966, project report stream flow, a 1350 mw(e) nuclear alternative located near Los Angeles, and an energy value adjustment recommended by a Federal Power Commission Technical Memorandum. Use of lower plant costs and stream flows and higher interest rates, all of which are probably more realistic, would have lowered the benefit-cost ratio. The figures given are from Alan P. Carlín and William E. Hoehn, "The Grand Canyon Controversy--1967: Further Economic Comparisons of Nuclear Alternatives," in U. S. Congress, Senate, Committee on Interior and Insular Affairs, Central Arizona Project, Hearings before Subcommittee, 90th Congress, 1st Session, May 2-5, 1967, p. 496. These figures also overstate the benefit-cost ratio because of a number of other assumptions favorable to the project, as specified in the paper.

<sup>c</sup>United States Department of the Interior, Bureau of Reclamation, Pacific Southwest Water Plan, Supplemental Information Report on Marble Canyon Project, Arizona, January 1964, p. 24.

<sup>d</sup>Based on a 600 mw(e) nuclear alternative located at Lake Havasu and a 10.55 million acre-feet annual stream flow, as derived in 1967 Senate Hearings, op. cit., p. 496.

BUREAU'S QUESTIONABLE BENEFIT-COST PRACTICES

In the course of the controversy,<sup>10</sup> as the Bureau of Reclamation sought to defend its analysis, it developed that the differences resulted from a number of economically questionable procedures the Bureau had used in computing its benefit-cost ratios. Of these, the most important from the point of view of economic theory are as follows:<sup>11</sup>

(1) Choice of what was claimed to be the "most likely" alternative rather than the least cost alternative

(2) Use of higher interest rates and taxes in evaluating the alternatives than the projects

(3) Insistence that any alternative must distribute energy to exactly the same customers as would allegedly be served by the projects, without regard to the objective of minimizing the cost of meeting demand in a regional power system.

In addition, although the Carlin-Hoehn studies have not made a major issue out of it, there have also been some questions raised concerning the Bureau's

(4) Use of a rate of interest below even current costs of borrowing by the Federal Government and with no allowance for the economic risks of the proposed projects.

(1) AND (2) MOST LIKELY ALTERNATIVE AND HIGHER INTEREST RATES

The Bureau defended<sup>12</sup> its use of what it claimed to be the "most likely" alternative on the basis of a Senate Document.<sup>13</sup> This Document states that "The usual practice is to measure [electric power benefits] ... in terms of achieving the same result by the

most likely alternative means that would exist in the absence of the project."<sup>14</sup> Further, the Document says that,

"When costs of alternatives are used as a measure of benefits, the costs should include the interest, taxes, insurance, and other cost elements that would actually be incurred by such alternatives rather than including only costs on a comparable basis to project costs as is required when applying the project formulation criteria under paragraph V-C-2(d)."<sup>15</sup>

In the case of the Grand Canyon dams, the Bureau obtained the costs of the "most likely" alternative from the Federal Power Commission, which interpreted the concept as follows:

"The alternative to a hydroelectric project should be the lowest cost alternative that normally would be selected for the most economic growth of the regional power supply in the absence of the project. The alternative power costs should be based on the types of financing, public or private, that would be expected to apply to the alternative plant. In the case of the Marble Canyon project, we believe that the alternative cost should be based upon a weighting of the cost of power from private and non-Federal public sources in the area in proportion to the amount of power expected to be provided by these sources. With the exception of the TVA area, it has been the policy of Congress not to authorize the construction of Federal thermal-electric plants. A federally financed nuclear plant is not, therefore, a reasonable alternative to hydroelectric power development outside the TVA area."<sup>16</sup>

This directly conflicts, it should be pointed out, with stated Commission policy with respect to projects that come before it for

licensing under the Federal Power Act. In Idaho Power Company the Commission said that,

"When the comparative economics of two mutually exclusive plans are to be delivered, it is essential that all plans be compared on as similar a basis as is possible from the record, and this would include the use of the same assumed basis of financing, whether that be private financing or Federal financing."<sup>17</sup>

Specifically, in computing the cost of the alternatives to the Grand Canyon dams, the FPC used the cost of power from five existing steam-electric plants "based on a combination of both private and non-Federal public financing in proportion to the electric power requirements of these groups in the market area."<sup>18</sup> The Commission does not state exactly what average rate it effectively used for capital charges, but it was probably between 10 and 15 percent.<sup>19</sup> Ignoring differences in depreciation charges, this can be compared with the 3.17 percent used by the Bureau.<sup>20</sup>

Whatever its legal standing may be, the trouble with the "most likely" alternative principle is that there is no economic justification for its use and no objective standards for its application. The "most likely" alternative is inherently a matter of judgment. Its faithful application would involve attempting to foresee whether a privately or publicly owned utility would build the marginal addition to a regional grid at some time in the future (due to the longer construction period generally required for a hydroelectric project) and to infer the type of plant, location, and cost of such a plant. The approximations inevitably involved in applying such a criterion have already been suggested by the FPC Memorandum. In this particular

case, the rapid introduction of nuclear power for new projects in the last few years suggests that the application of the "principle" may have engendered particularly inaccurate forecasts of alternative costs.

But even assuming that the Bureau or FPC can determine what is the "most likely" alternative, the principle runs into theoretical problems because the hypothetical utility is very likely to face quite different factor costs (particularly for capital) and taxes in selecting the type of plant to be built as its marginal project, and in costing the marginal plant. The result is that the power benefits of the hydroelectric project are valued at the cost to the hypothetical alternative supplier rather than the cost to the nation, the relevant consideration in cost-benefit analysis. This means that benefits are inflated by the amount of federal, state, and local taxes<sup>21</sup> and added capital costs the alternative supplier must pay. Taxes generally do not represent a real resource cost to the nation--just a politically acceptable way of raising revenue. Although the implicit interest rate used to derive the cost of the "most likely" alternative is probably close to that which would be appropriate for evaluating the project, the appropriate interest rate is subject to some debate. Not subject to debate, in the author's opinion, is that the same interest rate should be applied to the evaluation of both the project and the alternative.<sup>22</sup> To do otherwise is to value the resources used at different prices and hence to compare final cost estimates that are not comparable.

Senate Document 97 seeks to justify the use of the "most likely" alternative on the basis that this "standard affords a measure of the

minimum value of such benefits or services to the users."<sup>23</sup> The relevant question, however, is not the value to the user but the value to the nation. The social cost of the lowest cost alternative source represents an upper limit on the value of a project to the nation.

### (3) TRANSMISSION COSTS

The Bureau insists that transmission costs of \$6 per kw-yr be included in the cost of any alternative to Marble.<sup>24</sup> This compares with \$6.68 per kw-yr used in their Marble calculations.<sup>25</sup> Representative Morris Udall, the leading Congressional advocate of the Colorado River Basin Project, explains that "It is our contention, no matter where in the five states (California, Nevada, Arizona, New Mexico, and Utah) that a nuclear alternative or alternatives would be located, or even if you put one in Arizona and one in California, that substantially the same expenditure would be necessary to transmit the peaking power from the nuclear alternative to the same load centers as peaking power from the hydroplants would be delivered."<sup>26</sup> He then "demonstrates" the need for transmission facilities by showing the amounts of peaking power which, he claims (without supporting references), "will be required to be delivered to each load center." This includes about 7 per cent for Utah and Northern New Mexico, despite the Federal Power Commission's statement that in its computations of the cost of the "most likely" alternative it assumed that "Arizona, Southern California, and Southern Nevada would be the [only] area in which power from the two hydroelectric projects would be marketed."<sup>27</sup> But even assuming that Mr. Udall was factually correct as to the proposed distribution of Marble and Bridge power, his

claim that substantially the same distribution costs would be required can only be said to be highly dubious.

Even if one accepts for the moment Mr. Udall's assertion that the alternatives must serve exactly the same load centers as he alleges would be served by the dams, it does not follow that substantially the same costs would be involved. Nuclear alternatives can be placed much closer to load centers than the singularly remote Grand Canyon, and there is a marked difference between the costs of transmitting power east and west across Arizona and Southern California. By placing the alternative to Hualapai Dam near Los Angeles and the Marble alternative at Lake Havasu, most of Mr. Udall's alleged power distribution could be served with little additional transmission expenditures beyond a transmission line from Lake Havasu to Phoenix.<sup>28</sup>

The marked difference between the cost of transmitting power east and west across Arizona and Southern California reduces, if not eliminates, the cost of serving the remaining bits and pieces of load that Mr. Udall claims outside the major metropolitan centers near Phoenix and Tucson and along the Southern California Coast. Because present and planned generating capacity in Northern Arizona and nearby areas of adjoining states greatly exceeds present and projected peakload demands in the same area, there are now and are expected to be in the foreseeable future substantial exports of power to Southern California. Consequently, the cost of transmitting power eastward along present (and eventually planned) west-bound transmission routes from a Los Angeles-based alternative can be said to be negative. These savings are equal to the incremental costs of

transmitting an equal amount of power in quantity and timing westward.<sup>29</sup> These savings should be enough to pay for a substantial part and perhaps all of the transmission facilities that may be included in the Bureau's estimates from existing and planned west-bound facilities to load centers allegedly to be served by the dams in Eastern California, Northern Arizona, Southern Nevada, and Southern Utah.

But in any case, Mr. Udall's statement as to the proposed distribution of Grand Canyon power is not supported by any sources for his distribution, nor has the Bureau ever furnished a detailed analysis as to the length, voltage, or routes of proposed Bureau-financed transmission facilities. Since no contracts have been signed with potential users, this is hardly surprising. But even more important, it is really unimportant what the distribution would be since it is by no means correct that the alternatives to the dams must serve exactly the same customers. Perhaps the best theoretical formulation available is that recently suggested by A. R. Prest and R. Turvey:

"The (electric) supply system constitutes a unity which is operated so as to minimize the operating costs of meeting consumption....

"If we now try to apply the principle of measuring benefits by the cost savings of not building an alternative station it follows from the system interdependence just described that the only meaningful way of measuring this cost is to ascertain the difference in the present value of total operating costs in the two cases and

deduct the capital cost of the alternatives....In general,...a very complicated exercise involving the simulation of the operation of the whole system is required."<sup>30</sup>

It has not been possible for the author to carry out such a simulation, which would, in any case, be quite difficult given the lack of information on Bureau marketing plans. Nor has the Bureau made such a study available. However, because of the market-oriented nature of nuclear power plants, it is apparent that such a study would show that the transmission costs of the system with the nuclear alternatives would be substantially less than that of the system with resource-oriented dams that would be located far from any load center. In fact, given that the Bureau apparently plans to tie in its transmission system with that of WEST Associates, and to serve many of the same customers as WEST, and that the WEST System will exist with or without the dams, it would appear to be a safe assumption that a systems analysis would show that the transmission costs of the alternatives could be approximated by the cost of transmitting power to the nearest load center capable of absorbing the power. Where the alternative was assumed to be located in or very near a major load center, such as Los Angeles, the transmission costs were therefore assumed to be negligible in the Carlin-Hoehn studies.

#### (4) ABNORMALLY LOW INTEREST RATES

The Bureau of Reclamation insisted that the correct interest rate to use in the computations was 3-1/8 per cent. As shown in Table 1, the use of higher interest rates is significantly less favorable for the dams. The Bureau's 3-1/8 per cent once again rested on Senate

Document 97, which prescribes that the interest rate to be used in cost-benefit studies is the average rate for outstanding United States Government securities of at least 15 years' maturity at issue.<sup>31</sup>

Although there is considerable controversy within the economics profession as to both the theoretical basis for selecting a rate and the empirical methods for determining the rate chosen on theoretical grounds,<sup>32</sup> most students of the subject would probably agree that there are several problems with this particular criterion. In particular, it appears questionable whether the rate determined by this criterion accurately represents the long-term Government interest rate that is likely to prevail at the time projects now being considered would be constructed, and whether such a rate, even if accurately represented, is appropriate to use to evaluate Federal water resource projects such as the dams. Present interest rates<sup>33</sup> would seem to offer a better guide to rates at the time of construction of a project now being considered than an average of past rates, particularly when the average reflects a large representation from the 1940's when much lower rates prevailed than in recent years. In addition, the selection of rates for United States Government securities of at least 15 years' maturity at issue is a biased sample of even past long-term interest rates because of the 4-1/4 per cent ceiling imposed by Congress on interest payable on Treasury bond issues maturing in more than five years. Whenever interest rates exceed this level, as in 1966 and 1967, the Treasury is forced into short-term borrowing, which is not reflected in the averages computed according to the formula.

Even if the formula accurately represented the present cost of long-term Government borrowing, however, it does not include any allowance for the economic risks of the projects considered. Government bond rates are probably an accurate reflection of the cost of risk-free capital, but Federal water projects have proved to be far from economically risk-free. Most of the interest rates suggested by academic students of the subject have ranged from 5 to 10 per cent at times when Treasury bond rates were much lower.<sup>34</sup>

#### CONCLUSIONS

This review and analysis of the economic controversy over the proposed Grand Canyon dams has pointed out several Federal evaluation practices not fully brought out in previous analyses of Senate Document 97:

(1) The use of the Document's "most likely" wording to exclude lower cost alternatives from consideration. A review of the literature suggests that this may be the first time that this practice has been discussed in connection with Federal evaluation criteria.

(2) The inclusion of higher interest rates and taxes in evaluating a private alternative to a public project. Other writers<sup>35</sup> have brought out this practice with respect to previous sets of Federal guidelines. Castle, Kelso and Gardner<sup>36</sup> were apparently not clear whether this practice would be continued under the guidelines set down in Senate Document 97.

(3) Use of unreasonable assumptions with regard to the transmission costs of alternatives. This appears to be a new contribution to the

catalogue of faults of present evaluation procedures. Since Senate Document 97 is silent on the question, the problem is one of omission rather than faulty prescription.

(4) The particularly inadequate interest rates used in computing the cost of proposed projects during periods when rates are relatively high compared to previous decades. Most commentators on the subject have discussed the interest rate question. It is only during periods such as the present when interest rates are markedly higher than during the preceding several decades that the shortcomings of the Federal formula even as an indication of Federal capital costs and the risk-free interest rate become particularly apparent.

The significance of the Grand Canyon controversy for the evaluation of Federal water projects goes beyond underlining the inadequacies of Senate Document 97, however, to raise the question of whether it is possible for Federal water agencies to objectively evaluate projects which they would later be asked to build. In the case of (1) and (3), for example, the problems identified are at least as much a matter of the interpretation and application of the guidelines as they are of the present wording. Given the complexity of the subject, it would be difficult to write a set of guidelines that could not be misapplied, even if an effort were made to do so. Rather, what would seem to be needed is both a revised set of guidelines and an impartial group to apply them to each proposed project.

More generally, it would be naive to assume, especially in light of all that has been written about the evaluation of water projects, that the thinking represented by Senate Document 97 and its

application to the Grand Canyon controversy results entirely from ignorance of economic principles; much more can be explained by the political realities of the situation. The most important of these realities is the mutuality of interest between members of Congress anxious to obtain projects beneficial to their constituents and Federal water agencies looking for more business. Loose evaluation criteria serve the ends of both,<sup>37</sup> as does the practice of having the agencies themselves apply these criteria to individual projects.

FOOTNOTES

<sup>1</sup>For a fairly complete bibli'ography of this work, see A. R. Prest and R. Turvey, "Cost-Benefit Analysis: A Survey," The Economic Journal, December 1965, pp. 731-735.

<sup>2</sup>Emery Castle, Maurice Kelso, and Delworth Gardner, "Water Resource Development: A Review of the New Federal Evaluation Procedures," Journal of Farm Economics, November 1963, pp. 693-704; also David C. Major, "Notes on the New Standards for Evaluating Water Resource Projects," Journal of Farm Economics, May 1964, pp. 491-493.

<sup>3</sup>Luther J. Carter reports in "Grand Canyon Dams: Interior to Ask, 'Are They Necessary?'" Science, Vol. 154, October 7, 1966, p. 134, that a speech in July 1966 by John A. Carver, then Under Secretary of the Interior, but reflecting Secretary Udall's views, "amounted to a frank admission that the traditional approach [to water resource development planning] was faulty.

"Carver said that Congress and the public should be informed of the alternatives to hydropower as a means of financing water projects. 'Present procedures,' he said, 'do not provide an adequate comparison of such alternatives....Classically, legislation whether it be for a project or a government policy, has been presented by the executive branch to the legislative branch as an act of advocacy, the best possible case for a particular course of action or a single project. The process of identifying alternatives--indeed of discovering whether any exist--is left to the arena of countervailing powers in the political process.'"

<sup>4</sup>See U. S. Congress, House, Committee on Interior and Insular Affairs, Lower Colorado River Basin Project, Hearings before Subcommittee, 89th Congress, August 23 to September 1, 1965 and May 9 to 18, 1966, Serial No. 89-17 (hereafter referred to as 1965-66 Hearings).

<sup>5</sup>Ibid., pp. 1378 and 1397.

<sup>6</sup>Jeffrey Ingram, "Study of the Effect of Accelerating the Pay-Out of the Municipal and Industrial Costs: Lower Colorado River Basin Project," ibid., pp. 1472-1476.

<sup>7</sup>Representative Craig Hosmer, "The Battle of Grand Canyon," Per Se, Vol. 1, No. 4, Winter 1966, p. 23. See also Secretary Stewart Udall's reference to Hualapai Dam as "a gun pointed at the Columbia," in United States Congress, Senate, Committee on Interior and Insular Affairs, Central Arizona Project, Hearings before Subcommittee, 90th Congress, 1st Session, May 2-5, 1967, p. 162 (hereafter referred to as 1967 Senate Hearings).

<sup>8</sup>"Is the Marble Canyon Project Economically Justified?" 1965-66 Hearings, op. cit., pp. 1498-1510.

<sup>9</sup>Alan P. Carlin and William E. Hoehn, "The Grand Canyon Controversy--1967: Further Economic Comparisons of Nuclear Alternatives," 1967 Senate Hearings, op. cit., pp. 489-497; also in House Committee on Interior and Insular Affairs, Colorado River Basin Project, Hearings before Subcommittee, 90th Congress, 1st Session, March 13-17, 1967, pp. 619-625 (hereafter referred to as 1967 House Hearings).

<sup>10</sup>The major published statements by each side in addition to those already footnoted are Morris K. Udall, "Analysis of Alan P. Carlin's Testimony--'Economic Feasibility of the Proposed Marble and Bridge Canyon Projects, May 1966,'" 1965-66 Hearings, op. cit., pp. 1516-1519; Bureau of Reclamation, "Analysis of Alan P. Carlin's Testimony--'Economic Feasibility of the Proposed Marble and Bridge Canyon Projects, May 1966,'" 1965-66 Hearings, pp. 1519-1521; Alan P. Carlin and William E. Hoehn, "Mr. Udall's 'Analysis': An Unrepentant Rejoinder," 1965-66 Hearings, pp. 1521-1535; Morris K. Udall, "Analysis of Laurence I. Moss's Testimony, 'Considerations in the Use of Nuclear Power as Compared with Power from the Grand Canyon Dams,' May 1966," 1965-66 Hearings, pp. 1548-1549; and Department of the Interior, Bureau of Reclamation, "Comments on the Statement of Laurence I. Moss," 1967 Senate Hearings, op. cit., pp. 656-658.

<sup>11</sup>This by no means exhausts the list of differences; most of the others are items of less theoretical interest, such as the Bureau's omission of the value of water evaporated from the reservoirs and price increases since the Bureau made its estimates.

<sup>12</sup>"Analysis....," 1965-66 Hearings, op. cit., p. 1520. See also "Comments....," 1967 Senate Hearings, op. cit., p. 656.

<sup>13</sup>U. S. Congress, Senate, Policies, Standards and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources, Document No. 97, 87th Congress, 2nd Session, 1962.

<sup>14</sup>Ibid., p. 10.

<sup>15</sup> Ibid., p. 8.

<sup>16</sup> Memorandum of May 11, 1966, to the Commission from F. Stewart Brown, Chief, Bureau of Power, on the subject of "Marble Canyon Project, Arizona" (unpublished), p. 1.

<sup>17</sup> 14 F.P.C. 55, 63, as quoted in Federal Power Commission, "Decision, Arizona Power Authority, Project No. 2248, upon Application for License under Section 4(e) of the Federal Power Act (issued September 10, 1962)," p. 31.

<sup>18</sup> Memorandum of May 11, 1966, op. cit., p. 2.

<sup>19</sup> The FPC states (ibid., p. 2) that the five plants had capital costs of \$102 to \$120 per kw and that the computed cost of power was \$19.05 per kw-yr plus 3.37 mills per kwh. The fixed charge of \$19.05 is 17.3 per cent of \$110, but this no doubt includes other fixed costs besides capital charges on the generating plants.

<sup>20</sup> U. S. Department of the Interior, Bureau of Reclamation, Pacific Southwest Water Plan, Supplemental Information Report on Marble Canyon Project, Arizona, January 1964, p. 25. This figure includes depreciation of 0.17 per cent. The assumed life of the Commission's steam plants was presumably less than the dams, so that depreciation would be higher and the two rates of interest not strictly comparable.

<sup>21</sup> Although local taxes sometimes represent the cost of real services provided by local government. If they do, however, they should be added to the costs of both the project and the alternative.

<sup>22</sup>Perhaps the best reference is Otto Eckstein, Water-Resource Development (Cambridge, Massachusetts: Harvard University Press, 1958), p. 242.

<sup>23</sup>Op. cit., p. 8.

<sup>24</sup>"Analysis of Alan P. Carlin's Testimony...", 1965-66 Hearings, p. 1521.

<sup>25</sup>Based on U. S. Department of the Interior, op. cit., pp. 18, 20, and 25. Interest and amortization charges of \$4.65 per kw-yr are computed on the basis of a 3.17 per cent return (3 per cent interest plus depreciation as used by the Bureau, p. 25), and 8.5 per cent allowance for interest during construction (as in Bureau calculations, p. 25). At 3-1/8 per cent interest, the equivalent cost is \$6.83 per kw-yr.

<sup>26</sup>"Analysis of Laurence I. Moss's Testimony...", 1965-66 Hearings, p. 1548.

<sup>27</sup>Memorandum of May 11, 1966, op. cit., p. 2. It is interesting to note that no part of Utah is even shown in the "Power Market Areas" for either the Marble or Bridge Canyon Projects by the Bureau of Reclamation (see U. S. Department of the Interior, Bureau of Reclamation, Pacific Southwest Water Plan, Supplemental Information Report on Bridge Canyon Project, Arizona, January 1964, Drawing 65-314-28 and Marble Canyon Project Report, op. cit., Drawing 65-314-25).

<sup>28</sup>This is included in the costs of the Carlin-Hoehn Lake Havasu alternative to Marble (see "Further Economic Comparisons...", op. cit., 1967 Senate Hearings, pp. 490 and 494).

<sup>29</sup>Where the westbound lines would otherwise all be used during both off- and on-peak hours, the savings would only amount to the transmission losses for an equivalent quantity of power during on-peak hours. But where particular westbound lines would otherwise have to be built and one or more lines are used only for transmitting peaking power, the savings would amount to the full annual cost of building and maintaining lines to carry an equivalent quantity of power, as well as the transmission losses. These larger savings would seem to apply at least as far east as Hoover Dam and the Colorado River.

<sup>30</sup>Op. cit., p. 710.

<sup>31</sup>Op. cit., p. 12. The complete statement reads as follows:

"The interest rate to be used in plan formulation and evaluation for discounting future benefits and computing costs, or otherwise converting benefits and costs to a common time basis shall be based upon the average rate of interest payable by the Treasury on interest-bearing marketable securities of the United States outstanding at the end of the fiscal year preceding such computation which, upon original issue, had terms to maturity of 15 years or more. Where the average rate so calculated is not a multiple of one-eighth of 1 per cent, the rate of interest shall be the multiple of one-eighth of 1 per cent next lower than such average rate."

<sup>32</sup>For a brief summary and references to this literature, see A. R. Prest and R. Turvey, op. cit., pp. 697-700.

<sup>33</sup>Such as indicated by current yields on these same long-term bonds.

<sup>34</sup>At one end of the spectrum, Otto Eckstein recommended 5 or 6 per cent in 1958 (op. cit., p. 99). At the other extreme, Jack Hirshleifer, et al, recommended 10 per cent in 1960. See Hirshleifer, James C. De Haven, and Jerome W. Milliman, Water Supply: Economics, Technology, and Policy (University of Chicago Press, 1960), p. 146.

<sup>35</sup>See, for example, Eckstein, op. cit., p. 240.

<sup>36</sup>Op. cit., p. 701.

<sup>37</sup>Interestingly enough, what was to become Senate Document 97 was originally signed by the Secretaries of the Army, Interior, Agriculture, and Health, Education, and Welfare, although no doubt prepared by their staffs (including the Bureau of Reclamation and the Corps of Engineers).