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THE USE OF ECONOMIC ANALYSIS IN THE TENNESSEE  
VALLEY AUTHORITY: THE CASE OF THE DUCK RIVER PROJECT

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In September, 1968 the Tennessee Valley Authority recommended construction of two dams on the Duck River in middle Tennessee [15]. Subsequently, an environmental impact statement (EIS) was prepared which further described the plan and provided a summary of the national economic efficiency justification for its implementation [13]. Table 1 summarizes the EIS justification. However, the accuracy of the EIS analysis may be subject to question. This paper evaluates the sensitivity of the EIS national economic analysis to changes in expansion benefit estimates, reconsideration of cost estimates and their use, and the discount rate used for analysis.<sup>1</sup> Also discussed is the consideration given to alternatives to the Duck River Project, and institutional limitations on the TVA's mission that affect the use of economic analysis.

### ECONOMIC ANALYSIS

#### Expansion Benefits

Thirty-seven percent of the estimated project benefits (\$1,970,000) would result "from more productive use of subemployed labor in the region ... by the creation of more jobs in industry and related trades and services. The industrial growth would occur on sites that would be benefited primarily by an assured water supply of high quality" [13]. The quantitative magnitude of the benefit estimate is based upon a projection of approximately 3000 new jobs that will be created within 25 years to employ subemployed labor [13]. Procedural methods sought to insure that only immobile labor resources that would not be employed in the absence of the project were considered in computing national

Table 1. SUMMARY OF NATIONAL ECONOMIC EFFICIENCY JUSTIFICATION FOR THE DUCK RIVER PROJECT

Discount rate	4-5/8%
Construction costs	\$78,500,000
Annual costs	\$ 430,000
Annual benefits <sup>a</sup>	\$ 5,275,000
Benefit-cost ratio	1.3:1

<sup>a</sup>Includes benefits for flood control, water quality, water supply, recreation, shoreline development, fish and wildlife, road transportation savings, redevelopment, and economic expansion (employment of subemployed labor).

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<sup>1</sup> One means of testing the accuracy of a benefit-cost analysis is to make alternative assumptions about critical aspects of the analysis and then recalculate the benefit-cost ratio to see if the project is still justified. This procedure is recommended whenever some of the assumptions underlying an economic analysis may be weak ones [24].

economic efficiency benefits [15].

At least 1700 of the newly created jobs were attributed to expansion of the phosphate-processing industry. "TVA studies show that, with an adequate water supply, the potential for expansion of the existing elemental phosphate industry and the creation of a new secondary phosphate-processing industry could increase employment (in this industry) from about 1700 in 1965 to almost 3300 within 20 years" [17]. Remaining jobs would be in industries such as dyes and organic pigments and paper coating and glazing – all large water-using industries [17].

Industrial location decisions are based upon a variety of factors including, but not limited to, water supply. The labor force composition, tax structure, availability of raw materials, electric power rates, proximity to markets, transportation, etc. are all key considerations in any decisions to expand an existing industry or to locate a new one. This does not suggest that investments in water development may not be justified on other grounds, but it does suggest their limited role in promoting regional economic change [1, 3, 5, 9].

These general observations are borne out by the situation confronting the phosphate industry in the area – an industry that was projected to provide 1700 new jobs if offered an assured water supply. In fact, a phosphate reserve of diminishing quality associated with increasing costs of electric power have nearly eliminated all thoughts of potential expansion. Indeed, the future of the industry will be determined NOT by water supply problems, but by "continuing development of new methods of processing low grade phosphate ore" [7].

Garrison and Paulson found that water resources development in the Tennessee Valley may affect the location WITHIN the region of those firms who had chosen to move to the Tennessee Valley already. They conclude:

... public investment projects in the Tennessee Valley Region, which augment minimum streamflow to values greater than 400 cfs (cubic feet per second) will in fact favorably alter the location characteristics of small areas for those manufacturing activities defined as water intensive (emphasis added) [4].

However, the maximum reliable flow available in the Duck River with the project in place is only 150 cfs [15]. Therefore, based on the Garrison and

Paulson criteria, even with the proposed construction the Duck River will still not provide an adequate water supply as a means of attracting industry. On the other hand, TVA has already built or acquired 27 major dams, owns one million acres of land around reservoirs containing 638,000 surface acres and over 10,000 miles of shoreline [14]. These gross figures are suggestive of the supply of water available within the region. Given this fact in combination with the findings of Garrison and Paulson, there seems to be little reason for thinking that the Duck River Project would be an attraction to industry.

Thus, it appears that the expansion benefit estimates may be subject to error although no precise estimates of this error are made. Subsequent discussion of the expansion benefit claims will therefore test the sensitivity of the EIS analysis by determining what change in the expansion benefit estimates is necessary for the benefit-cost ratio to equal unity. Then the question is whether such a change seems reasonable in the context of the previous discussion.

### Contraction Losses

Completion of the proposed project will require acquisition of 41,000 acres of land, part of which will necessitate the removal of 176 farms from operation, or alternatively viewed, 5.5 percent of the agricultural production in the four county project area [13].<sup>2</sup> Insofar as this removal creates underemployment of immobile resources in the project area, it represents a national economic efficiency cost. The magnitude of this cost will be roughly estimated below. To better understand the procedure used, the conceptual foundation for the argument will be discussed first.

When doing a benefit-cost analysis, the assumption is often made that the economy is operating at full employment in all regions. As discussed above, this is not the position taken in the EIS. It argues that some project benefits will accrue to employment of unemployed or underemployed labor. The EIS is correct in this position if it assumes, as it does, that these resources are immobile and will remain unemployed in the absence of the project.<sup>3</sup> Using the same logic in reverse, actions which create underemployment of immobile resources are a national economic efficiency loss [24]. With respect to the Duck River Project, it is assumed that the many firms in the project area, whose income depends upon the volume of farm sales, will not be

<sup>2</sup> The immediate project area is defined as the four counties of Bedford, Maury, Marshall and Coffee.

<sup>3</sup> As McKean notes with regard to this point, "If in the absence of the project, certain resources would be involuntarily unemployed throughout the time period, then the incomes of these resources throughout the time period can be viewed as a gain due to the project." [6], p. 158.

mobile enough to move when some farms are displaced by the project - in fact, the loss for any single firm would probably be too small to justify a move. Thus, these firms will suffer some income loss. Income gains due to employment of subemployed labor may more than compensate for this loss, but still it is the NET gain that should be considered.

Empirically estimating a regional loss that had national significance presented a difficult problem. The procedure used can be summarized as follows. A regional multiplier value developed in the context of an input-output table was applied to lost farm sales in the project area to estimate the total loss in sales in the area. The best available model was for the State of Tennessee, and this multiplier was used. Furthermore, the multiplier values used reflect the impact of different economic sectors on total sales, and the national economic efficiency impact should reflect changes in incomes. Therefore, value added (available from a national input-output model) associated with sales was used to gain an estimate of income losses. Clearly the resulting loss estimate is a rough one. However, consistency in calculation of the net national economic efficiency effect of the project suggested that contraction as well as expansion benefits associated with subemployment be considered.

The actual empirical estimate was carried out as follows. Weighting the Tennessee multipliers for particular agricultural products by the percentage that these different products are of production in the four county project area, resulted in a weighted multiplier of 1.60.<sup>4</sup> With total sales of farm products in the four county area equal to \$35,410,590 in 1969, and 5.5 percent of farm production being lost due to the project, the equivalent loss in annual farm sales is \$1,947,583 [20]. The multiplier of 1.60 places the total loss in annual sales in the area at \$3,116,132.

While the loss in value added from direct farm production is considered in TVA's payment of market value for the farm land taken for the project, the value added associated with loss sales in other sectors (that here represents a measure of subemployment created by the project) has not been accounted for. A value added figure of 30 percent was applied to these sales of \$1,168,549 (\$3,116,132 - \$1,947,583) resulting in an estimated loss of \$350,564.<sup>5</sup> These steps are summarized in Table 2.

### Land and Relocation Costs

Firms and households standing in the path of federal resource development projects must be awarded a fair market value for their properties as well as compensation for costs associated with moving [18].

Since payment of relocation costs is legally necessary for the construction of the project, such costs should be included in the calculation of a benefit-cost ratio.<sup>6</sup> Besides the institutional constraint on what must be counted as costs, there are reasons for viewing these costs as efficiency losses. To pay relocation costs, funds will be withdrawn from the private sector or other public programs. This action imposes opportunity costs that have the same efficiency implications as the raising of revenue to purchase concrete or land for the project. The EIS recognized the requirement to make relocation payments, but did not accurately include these costs in its analysis.

The 176 farms displayed by the project are entitled to a fixed payment equal to annual net earnings of the farm operation based upon a recent two year period, although such payment may not be less than \$2,500 or greater than \$10,000. Average annual net farm earnings of farms in the project area in 1969 equaled \$2,529 [20]. Therefore, although the

**Table 2. SUMMARY OF STEPS IN COMPUTING CONTRACTION LOSSES**

1. Total of farm sales (4 county area)	\$35,410,590
2. Farm sales lost due to project (5.5% of farm sales)	\$ 1,947,583
3. Total of all lost sales (1.60 X farm sales lost)	\$ 3,116,132
4. Lost sales in other than farm production (3,116,132 - 1,947,583)	\$ 1,168,549
5. Lost value added (30% of lost sales other than farm production)	\$ 350,560

<sup>4</sup> For a brief discussion of what a weighted multiplier is in a slightly different context, see [25].

<sup>5</sup> The 30 percent figure for value added is considered a conservative estimate. Using a national input-output table, the value added associated with "Agriculture, Fishery and Forestry Services" is 32.8 percent of sales. Value added is 30.9 percent of "Fertilizer and Miscellaneous Chemicals" sales. In fact, these two sectors that had a direct relationship to agricultural production were among the lowest in value added among all sectors of the economy [21].

<sup>6</sup> In addition to [18], Senate Document 97 is rather clear on this point. "The value of goods and services necessary for the establishment of the project including initial projection construction; land, easements, rights of way, and water rights; capital outlays to relocate facilities or prevent damages" are part of project cost [8], p. 11.

displaced farms cannot be specifically identified, a minimum income figure of \$2,500 per year per farm can be used. This requires an addition of \$440,000 to project cost. Also, payment of up to \$15,000 for displaced homeowners' expenses is authorized. The amount paid depends upon differentials in prices for new homes and the market value of the current home, increased interest costs, and closing costs of new home purchases. Since there is no concrete data to base estimates on, the figure of \$3,000 per household was selected as a conservative estimate. Including the farm units, 396 households will be moved [13] at a cost of \$1,188,000. Therefore, additional costs of \$1,628,000 should be included as part of construction costs, making total construction costs \$80,128,000.

In estimating a project benefit-cost ratio of 1.3:1, the EIS does not include the cost of land acquired for project purposes in its calculation of annual interest and amortization charges associated with capital costs [13]. The fair market value that is paid for land must be considered as much a part of construction costs as cement or labor. Therefore, in this critique of the EIS analysis, total construction cost, including costs of land, is used in calculation of benefit-cost ratios.

#### Discount Rate

The question of the appropriate rate of discount for use in economic evaluation of water resource projects has been debated with increasing frequency in recent years [22]. Although no definitive conclusion has been reached, the debate has encouraged a continuous rise in the mandated rate of discount since 1968.<sup>7</sup> For purposes of this critique

the administratively set rate of discount will be considered appropriate for analysis. In April, 1972, the date of the EIS release, 5 3/8 percent was the mandated rate of discount although 4 7/8 percent was used in the EIS analysis. Also of interest is that a rate of seven percent has been proposed for the near future [24]. While not yet in effect, it will be useful to consider the sensitivity of the EIS analysis to the use of both the seven percent and 5 3/8 percent rates, since the seven percent rate may be in effect before work on the project begins.

#### Sensitivity Analysis

The previous discussion has identified some potentially sensitive aspects of the economic analysis in the EIS. These several points can now be aggregated to test their effect on the project's economic worth. In Table 3 alternative discount rates are displayed on the left. Column a shows the benefit-cost ratio using EIS benefit and cost estimates with different discount rates but including land costs in calculating the benefit-cost ratio. Column b shows the benefit-cost ratios with the effects of contraction and relocation considered. Column c shows the percentage change in expansion benefits necessary to make the benefit-cost ratio equal one, including contraction and relocation effects.

As Table 3 indicates, the economic worth of the Duck River Project may be subject to serious question. Only by ignoring contraction and relocation effects and using the lowest discount rate is the benefit-cost ratio greater than one. After considering contraction and relocation effects, the expansion benefit estimates would have to be INCREASED in every instance in order to raise the ratio to unity. The

Table 3. SENSITIVITY ANALYSIS OF EIS ECONOMIC JUSTIFICATION

	a Benefit and Cost Estimates - EIS	b Benefit/Cost Estimates With Contraction And Relocation	c Percent Change In Expansion Benefits To Make B/C = 1
r = 4 7/8%	1.090	.998	+ 0.4%
r = 5 3/8%	.999	.904	+ 27.0%
r = 7%	.748	.685	+ 115.0%

<sup>7</sup> This rise has resulted in large part from Water Resource Council actions to develop new techniques for estimating the discount rate [23].

previous discussion suggests that such an increase may be unjustified. In fact, a better argument could be made for reducing the expansion benefit estimates. Thus, it appears that the construction of the Duck River Project will result in a loss to the national economy, not a gain as the EIS analysis suggests.

### A COMMENT ON ALTERNATIVES

In the management of water resources a primary goal should be to maintain the ability to remain flexible over time in directing the pattern of resource development.<sup>8</sup> Projects such as the Duck River dams involve long term commitments of resources that may preclude this type of incremental decision making. If sufficient justification can be presented for making such long term commitments, then this may be the wisest course of action, but as Table 3 suggests the Duck River dams may be economically unjustified. Therefore, alternative schemes for managing the resources of the Duck River should be considered. Some general comments about alternatives are made below.

EIS projections of growth in population and industry depended upon increases in water supply. However, these same projected needs could be satisfied by two small reservoirs on tributaries to the Duck River at a cost of \$770,000 on an average annual basis [13]. Water quality enhancement techniques of equal effectiveness to the low flow augmentation releases from the project could be provided at an average annual cost of \$295,000 [13]. In addition, the environmental values associated with a free flowing river in the midst of the Tennessee Valley should be considered. The Duck River now is the longest free-flowing stream left in the Valley [16]. Currently, the river receives 17,000 annual recreation visits for white water canoeing and floating [13]. Indeed, the potential of the area for river oriented recreation is well recognized. The Duck was one of ten rivers in Tennessee included in the Bureau of Outdoor Recreation's original "Wild River Study." In 1967 the Tennessee Department of Conservation and Tennessee Game and Fish Commission recommended national scenic river status for the Duck. The river was included in the original bill that resulted in the Tennessee Scenic Rivers Act of 1968, and after it was removed from the State bill by pro-dam forces, Governor Ellington recommended its inclusion in the National Wild and Scenic Rivers System [19].

However, of most significance from the national economic efficiency standpoint is that the nation's economy might be better served by construction of

smaller scale projects. The EIS projections of needs for water supply and water quality could be provided at an average annual cost of \$1,065,000 or 27 percent of the annual project costs as estimated in the EIS. Funds released by such a development approach might be spent for roads, schools, enhancement of river oriented recreation, etc. - all potentially important elements in a flexible development plan for the region. A plan of this nature would provide a broader base for attraction of commercial and industrial growth, while at the same time preserve a unique recreation resource and not force a contraction of agricultural and related economic sectors.

### TOWARD A BROADER MISSION FOR TVA

The current TVA program was given its initial direction by the early legislation under which it was created. Toward the goal of promoting the economic growth of the area through water resource development, the authority was to

... have power to construct such dams and reservoirs in the Tennessee River and its tributaries ... [to] provide a nine foot channel in the said river and maintain a water supply for the same ... [to] best promote navigation ... [11].

In addition, the authority was to

... [operate] any dam or reservoir in its possession and control to regulate the stream flow primarily for the purposes of promoting navigation and controlling floods. So far as may be consistent with other purposes ... [the authority] is authorized to provide and operate facilities for the generation of electrical energy at any dam [11].

With this mandate, the Authority embarked upon a program that turned the Tennessee into a navigable river along its entire length. With this task accomplished, increasing focus was placed upon development of tributary streams. Associated with this shift in focus was an increase in the number of water related purposes considered in planning. The Duck River Project, for example, considers eight purposes that were not specifically provided for in the original legislation. Indeed, now projects frequently do not even consider purposes such as navigation and electric power generation. In this sense, the Authority has redirected its mission toward meeting the changing needs in the Valley.

<sup>8</sup> For a detailed discussion of this particular point, see [12] pp. 67-87.

However, while the number of purposes considering in planning now reflects a true multiple purpose perspective, the means considered for addressing these purposes have often remained as narrow as the original legislation dictated – the building of large dams and reservoirs as water control structures. Meanwhile, the desire for economic progress in the Valley remains, and water related needs continue to exist. Local and congressional interests seeking both satisfaction of such needs and economic progress through the TVA structure must frequently support what is recognized by law and “custom” as the single alternative available to the Authority. This support inforces the tendency toward promotion of that single option. In fact, it appears that careful planning could identify a number of alternative means of meeting the purposes identified as important in the Duck River area. To suggest that TVA implement such alternatives may demonstrate the economic wisdom of such an approach, but ignores limitations of authority and custom on what TVA can and will consider in their program. Thus, the TVA water resource management program can best be characterized as “multiple purpose-limited means.”

As such the increase in purposes served often has been used to perpetuate the promotion of a single means by increasing the purported social justification for large structures beyond the provision of navigation, flood control, and electric power generation. Insofar as benefit-cost analysis is used to ascribe market and simulated market values to these multiple purposes, it too must be seen as a method of justification for a single means, rather than a way of

evaluating the relative worth of alternatives. Thus, economic analysis often is accommodated to political constraints rather than reflecting sound analytical techniques.<sup>9</sup> The weakness of the economic justification for the Duck River project suggests that this type of accommodation may have occurred.

Attempts to further refine the techniques for measuring the economic worth of alternative management schemes [24] cannot hope to succeed in an institutional environment that often uses evaluation techniques such as benefit-cost analysis to justify particular actions rather than use it as a tool for assisting the process of choosing between alternatives. Therefore, TVA must depart from its historical focus on construction of large dams to seriously consider and implement alternatives such as those suggested earlier for the Duck. To some extent this has occurred in other areas of the Tennessee Valley, but greater efforts must be made. Perhaps consideration of broader areas than the natural resource realm should be encouraged. The areas of planning for housing, new town development, highways, and education all come to mind. A plan for orderly development of the region must consider much more than seeking to tap the productive potential of natural resources [2].

As long as the people of the Tennessee Valley seek economic progress, a well respected regional institution such as TVA can greatly assist in attaining this goal. However, considerations of only limited alternatives that may in fact work against attainment of this goal should not be perpetuated by the misuse of the carefully developed tools of economic analysis.

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<sup>9</sup> While limitations on the legal authority of a planning body is of key importance, other factors influence what they do and expressions of political support they receive. A few such factors are organizational structure, training and bias of staff personnel, and financial cost-sharing requirements. For a complete discussion of these points, see [10].

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