PURPOSE AND UTILIZATION OF ECONOMIC BASE STUDIES IN WATER RESOURCE PROJECTS

by

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I - Need for Economic Base Study

What will be the population in Jackson, Mississippi in the year 2020? Will the per capita income of those residing here be in the $1,000, $2,000, or perhaps $5,000 range? How many workers do you think will be employed by plants producing paper and allied products, chemicals, or petroleum products? To become still more refined, what percent of those people living here will be more than 12 years old and what will be their median level of education? By now you may be wondering just what these characteristics of economics and demography have to do with water resource development. The answer is - plenty - if you are attempting to plan projects that will adequately meet the needs in this area for the next 50 years.

This is the type of information that is usually developed in an economic base study. This study identifies and measures, insofar as practicable, the social, physical, economic, and technological factors that affect economic development and growth. First a thorough analysis is made of existing economic conditions including a compilation of available historic data on such measures as population, personal income, and employment. Past and present trends are compared with national and regional growth. If they differ, an attempt is made to identify the factors that produce this variation. Next, the available raw material, people, geographic location, climate, and other resources of the study area are inventoried to evaluate the potential development of the area. Finally, the trend and magnitude of future activity is expressed in terms of population, personal income, employment, households, land use, agricultural and industrial production, and other indicators of economic activity usually for the next 50 years. These projections, either singularly or in combination, have a relationship to one or more purposes of water resource development; thus, they may be translated into water needs.

Perhaps you have seen the model showing what greater Jackson will look like in 100 years and are thinking that this "look into the future" is all right for Chamber of Commerce presentation and for dreamers, but certainly not as the basis for constructing dams, or navigation channels, boat launching ramps, or hydroelectric power plants. After all, who can accurately predict what will happen 50 years from now? Certainly, the economists that prepare these "looks into the future" for economic base studies would be quick to point out that they are not predicting, but are instead projecting. They study the historical patterns, apply certain modifications based on changed technology or social habits, and show what

can be expected in the future if these assumptions hold true. The purpose of these projections is to present likely central trends and values. They are approximations, at best, and a high degree of precision is neither possible nor intended. Accuracy will decrease as the study area becomes smaller and as the period of time is extended farther into the future. Even though we cannot accurately foresee all the technological changes - and who could have anticipated all of the scientific achievements of just the past 20 years - we must estimate, project, and assume to the best of our ability if we are to keep abreast of the water connected needs of this Nation. In fact, the goal should always be to phase the construction program so that the supply is available slightly before the need exists. Undoubtedly, plans based on projections of future population and economic activity will come closer to meeting future needs than plans that always assume that conditions will remain static, or assume arbitrary conditions.

The purpose of this presentation is to present some of the advantages of using economic base studies, to discuss in general terms how some of the products of economic base studies are translated into water or water-related requirements, and to mention some points that should be considered when developing an economic base study. No attempt will be made to establish rigid procedures that should be followed throughout the Nation.

Normally, an economic base study is more appropriate for use in connection with planning studies that encompass entire river basins than it is for a single project. (However, even the single project investigation requires an assessment of past, present, and future activities in the area as a starting point in evaluating all water-related requirements.) The subsequent comments apply to studies of larger areas which are usually referred to as comprehensive river basin studies. These comprehensive studies start out by estimating the requirement for all types of water resource development in the basin for the next 50 or 100 years. Next, the ability of nature to satisfy these requirements is evaluated before anyone starts looking for project sites. This is a much more objective approach than starting out with the recommendation that a reservoir or channel be constructed at a particular site and then analyzing the benefits that might accrue. The first step in conducting a comprehensive study is to prepare an economic base study to help us estimate needs.

Evaluating needs for an entire basin for a 50-year period makes it possible to prepare a chronological list of detailed project studies that should be undertaken in the future. For instance, perhaps there is no need for reservoir storage in the basin today. But based on the projected population, industrial production, and personal income, one appears to be needed in about 30 years. When should the feasibility study be made? Probably in about 15 years. Why? Because the timetable on a large reservoir goes something like this: The feasibility study and review takes two to three years at least, then about two more years go by while the project is authorized and funds appropriated, two or three years are required for preconstruction planning, and five to seven years are needed for construction. Therefore, about 15 years may pass between the time someone decides a reservoir is needed and the

actual closing of the gates. As a result, if the need exists before you start planning, the economy of the area will probably suffer for about 15 years. And while everyone concentrates on building this emergency measure, other unsatisfied needs are probably developing and growing. Thus, if water resource planning "plays it by ear" and waits for the need to emerge, then efficiency and objective planning are lost and haphazard planning results. As time goes by the need for projections into the future in connection with water resource planning becomes more acute. Let's assume that the population of an area is doubling every 20 years and goes from 30,000 in 1930 to 60,000 in 1950. Probably some action was necessary to satisfy the demand for water created by this increase. However, from 1970 to 1990 the population is going from 120,000 to 240,000 and the magnitude of increased demand is probably even greater because people use more water as their economic wellbeing improves. So maybe it wasn't so critical if we failed to plan adequately for growth and change in 1930, but in 1970 it will be disastrous if we fail to look ahead.

Today, flood control, drainage, water supply for municipal, industrial, or irrigation use, recreation, fish and wildlife enhancement, navigation, erosion control, water quality control, and hydroelectric power are all considered equally important purposes in water resource development. Care must be taken to insure that one purpose is not improved at the expense of another. The projection of demands for all purposes enables the planner to properly consider each purpose in the plan for the future. For instance, at the present an area may have sufficient natural habitat for fish and wildlife to satisfy today's hunters and fishermen. However, tomorrow's projections may present a different picture. It may be necessary to relocate a reservoir presently under consideration to prevent destruction of an area that will be needed in the future and cannot be replaced.

An economic base study only partly solves one of the planner's problems of tomorrow. It indicates the tremendous need in many cases for reservoir sites for future development, particularly for storage for water supply and to provide water surface for recreation. Often there are only a limited number of sites, and it is obvious that they should be preserved for the future. However, a satisfactory method of preempting development in the reservoir area has not evolved and none is apparent short of actually leasing or buying the land that is involved. Even though the economic base study does not solve the problem, it does point out the need at a time when something can still be done about it. In addition, these projections often clearly establish the need for optimum development of the reservoir site even though the total storage is not required initially.

A number of water resource planning agencies usually participate in comprehensive planning. Use of a single economic base study assures that the same population, personal income and other indicators are used in 1980, for example, for the same area regardless of the purpose being considered. Thus, the same basic data are used to estimate the water supply storage, fishing opportunities, or the flood-free acres required. Not only is repetitive effort avoided, but compatibility of estimates is assured. For example, flows required for water quality control are based on the same industry mix and

production as the water supply storage for industry. Accordingly, water projects are provided to complement one pattern of land use and development. Thus, assumption of more than one use for the same land is avoided. An extreme example of possible double counting would be for one agency to plan projects based on increased agricultural activity in the valley and another to assume conversion to industry and urban use on the same land.

II - Translation of Indicators to Needs

Discussion up to this point has dealt primarily with the reasons for using an economic base study when planning water resource projects. The next section will illustrate how the information contained in an economic base study can be used to develop the water and water-related needs in a basin. Needs referred to here are the total requirements for the area regardless of the probability they can be satisfied by nature or the probability they can be met by projects which are economically justified. These two points would be evaluated in a subsequent step in the comprehensive study and are beyond the scope of this paper.

Need for water resource development is directly related to the economic growth of the area. Therefore, expressions of economic growth, referred to as parameters or indicators, are used to help estimate the future water needs. All economic growth stems from activities undertaken to satisfy human needs; thus, all water uses are connected with population to some degree. In addition, other indicators such as employment, agricultural and industrial production, personal income, household, and land capability may have a major influence on the magnitude of an estimated need. In fact, an infinite number of indicators could be analyzed; however, this analysis is costly and judgment should be used to eliminate those that have only a small effect.

To determine what needs the plan for the orderly development of the basin should attempt to satisfy, the planner must establish the area of influence or the area on which this need should be based. Usually the area differs for almost every purpose. Need for flood protection is limited to lands in the drainage basin under study. In addition, the national picture must be evaluated to determine the capacity of existing cultivatable land to furnish food and fiber for the Nation. Water supply also follows the basin boundaries except that export of water should be considered if critical areas exist in adjacent basins. Recreation demand area is based on a reasonable commuting distance; therefore, it normally includes areas outside the basin, sometimes as much as 100 miles. Pollution needs are usually confined to the basin but the demand area sometimes extends downstream if relief is needed in lower basins. Hydroelectric power demand is computed for a market area without relation to the basin boundary.

Here are some of the ways that economic indicators are used within these areas to estimate present and future needs:

a. Municipal water supply. This requirement in million gallons per day is estimated on a per capita basis. Therefore, in this as in almost all needs, the present and future population is a necessary input. However, the per capita use varies in relation to personal income. An increase in personal income in the basin in the future is assumed to produce the same change in per capita consumption that this increase in personal incomes produces on the national level at present. For example, let's assume that the personal income in the basin under study is estimated as shown in the second column of this table.

	Per Capita Income		Per Capita Water Use
	Basin	National Equiv.	Basin
	1,500	2,000	140
1970	1,700	2,260	150
1985	2,000	2,660	165
2020	3,000	3,990	195

Then the 1965 per capita use in the basin and the national per capita use for various levels of income must be ascertained. The national level of income that produces the same per capita use that exists in the basin is 1.33 (assumed) times the basin personal income. Therefore, projected personal income for each year shown for the basin is multiplied by 1.33 to get its national equivalent, and the per capita use that exists nationally for that level of income is assumed to be the future use in the basin. This per capita figure is then multiplied by the population projected for the year in question to get the daily municipal water use.

b. Industrial water supply. Industrial water may be supplied by municipal or private sources. One of the first steps then, is to ascertain the actual water use patterns at present. Sometimes the number of employees or earnings in heavy water-using industries is used to indicate future industrial use. In this case, these indicators must be multiplied by the quantity of water required per employee or per dollar of earnings. However, the employees or earnings per unit of production and the water required per unit of production vary widely from one plant to another. Therefore, the most reliable means of estimating industrial water requirements is to identify and locate the number of water-using industries and to project their future requirements based on anticipated production and gallons of water needed per unit of production adjusted to reflect changes in plant efficiency. Today, many plants located in areas of abundant water supply have done little to reduce water requirements because water is readily available and inexpensive.

Thus, as water shortages develop, the volume used per unit of production will probably be reduced. The two major uses of industrial water are for removal of excess heat and for processing of manufactured products. Included under removal of excess heat is water needed for air conditioning. This is a rapidly growing need that must be carefully projected. The principal difficulty in evaluating requirements for processing water occurs in areas relatively undeveloped industrially at the present. In this case, the resources of the area must be carefully analyzed so potential new industries, if any, may be identified and their probable production levels determined. Future growth trends for existing industries may be tied to anticipated gross national product, to projected production for these industries in the United States, or past growth. Usually projections assume that the area under study will participate in the changes in the national economy at about the same level that it has in the past. Naturally there are exceptions due to such things as limited natural resources. Therefore, each industry must be individually studied. Projection of industrial production and water use is one of the more difficult tasks assigned in an economic base study.

c. Irrigation water. Every economic base study includes a section on present and future land use in the area. The total annual requirement for irrigation water in acre-feet is computed by multiplying the number of acres dedicated to irrigated crops by per-acre demand for supplemental water. A slight decrease in this per-acre demand is usually envisioned; contrarily many agricultural specialists estimate that in the future it will be necessary, or at least justifiable to irrigate a much larger percent of what we now refer to as "dry crops". Therefore, if the basin under consideration is largely geared to agriculture and will probably remain so, the economic base study should treat present and future irrigation practices in considerable detail.

d. Recreation. This is rapidly becoming one of the most demanding purposes of water resource development, and at the same time, is a purpose on which only limited data are available as background for projecting future demand. Naturally, population is the most important single factor that should be considered. Also a number of economic parameters apparently affect recreation participation rates, including such things as personal income, median age, educational level, mobility, leisure time, and population density. Personal income probably reflects the effect of changes in all these factors better than any other single indicator, thus the change in personal income is often used to develop the change in participation rates. In many cases the available data indicate that the activity participation rate varies directly as does the personal income. Thus a person with an income of $6,000 per year can be expected to go motorboating twice as many times in a year as one with a $3,000 per-year income. Several exceptions have been taken to this one-for-one increase. One is that while doubling the income from $3,000 to $6,000 might double the participation - doubling it from $10,000 to $20,000 might not; therefore, some sliding scale might be in order. The other contention is that a person will increase his participation as he improves his position on the economic ladder, but that an overall increase in the personal income of the entire Nation will have a reduced effect. Regardless, facts to date show generally that an increase in personal income produces an equal increase in recreation participation. Total participation will be determined by multiplying the

total population by the participation rate adjusted to reflect the change in personal income. Therefore, personal income shows up once again as one of the most important parameters that should be developed in the economic base study. Incidentally, this compound effect of increases in population and personal income on recreation demand can be astounding. For instance, in the adjacent Big Black River Basin the population is projected to go from 235,000 to 379,000 and personal income from 1,325 to 2,873 between 1965 and 2015. As a result, the need for such recreation facilities as surface acres for boating or for camp sites in 2015 is estimated to be three and one-half times the requirement for 1965. Sometimes the results produced by translating economic base study results into water requirements are hard to accept.

e. Navigation. Often determination of the need for navigable waterways is more complex than some of the other water development purposes since the feasibility of water movement must be compared with land methods or a combination of water and land transportation to establish the need. To start with, the volume of commodities that could move on a navigable waterway must be developed, and this is where the economic base study is employed. Quantities of raw materials used in industry in the study area, such as crude oil, coal, iron ore, and soybeans, are obtained for the present. Similarly, the volume of goods, such as steel products and fertilizer, that these industries produce is determined. Added to these commodities are others demanded by the population of the area that could be water shipped, such as gasoline. And finally, the natural resources, such as coal, ores, and gravel and agricultural products, available in the area that are marketed outside the basin or in other parts of the basin, are combined with the first three groups to form the total potential waterborne commerce. Of course, this is present tonnage. Some factcrs must then be developed to project these volumes into the future. For the raw materials and finished products, the future production of industry located in the study area must be estimated. Commodities that will be used by residents of the study area are projected to fluctuate with the population after it is adjusted for gains in personal income. Raw materials may be assumed to vary at the same rate as employment or production in the appropriate manufacturing industry on the national level. In the case of agricultural products, the potential tonnage of the future can be anticipated to grow in proportion to projected needs for this food or fiber for the Nation. Growth will be limited by the amount and quality of land and allied resources in the study area. There will, of course, be exceptions that will have to be taken into consideration, such as raw material of limited supply that will be exhausted, a new industry envisioned for the future, or an untapped raw material that could be used if an economic means of transportation were provided. As stated earlier, the tonnages thus computed, both present and future, would be a total potential movement for a waterway or waterways. Certainly some of these commodities could be transported more economically by an alternative means. This requires a rate or cost analysis which is beyond the scope of this discussion.

f. Fish and wildlife enhancement. The principal basis used to determine the extent of the habitat for fish and wildlife that should be preserved or provided is the human demand for hunting and

fishing opportunities. The rates of participation in the appropriate hunting and fishing activities are usually known at present, but if not, this information must be ascertained. The rate of participation usually varies depending on whether the population is urban or rural, and if urban - what size municipality is involved. These rates are then adjusted for the future by some percent of the change in personal income. The product of these rates and the population will then provide the fishing and hunting demand for the selected year which can then be converted into area required for fish and wildlife habitat. Of course, some areas contain unusual scenic attractions or habitat for fish, birds, or animals that threaten to become extinct. In such a situation, the area should be preserved. This is usually handled at the national level, and this information is often available before a comprehensive study begins. If not, they should be identified.

g. Pollution. Pollution falls into three categories - natural from areas such as salt flats; municipal from sewerage; and industrial such as, but not limited to, brines from oil fields or wastes from paper mills or strip mines. Provision of dilution water to make low flows acceptable is not considered a cure for pollution but a treatment. All reasonable steps to preventing pollution from entering the stream should be taken; therefore, the need for supplemental low flows to offset pollution should be limited to those required after all reasonable treatment measures are employed. Natural sources are usually known and stable; therefore, a fixed dilution flow is used throughout the period of study. Present and future sources of polluted effluent from industry must be identified in the economic base study. Based on probable production and processes, the quantity and quality of the polluted effluent must be estimated so that the volume of dilution flow needed can be determined. Dilution for municipal sewerage is required most often when treatment plants discharge into streams that dry up and become stagnant in summer. In the past, pollution requirements have sometimes been designed to render water acceptable for one or several uses. Today, unsightly streams with objectionable odors are unacceptable and water quality control must be considered from an esthetic viewpoint.

h. Flood control and drainage. The economic base study contains a section on land use listing lands that should be available for various purposes. The need to protect additional acres for agricultural purposes should be based on the national need, if any, for additional land to produce the food and fiber required for the Nation and for any anticipated export. Sometimes, even though additional agricultural land is not needed, flood protection is needed for bottomlands so cultivated crops can be relocated from less desirable land. The present and future yields and production costs developed in the economic base study are applied to evaluate the flood control benefits. The need for flood prevention and drainage improvement for urban and industrial development is usually local in nature and is pointed out at public meetings, etc.

i. Hydroelectric power. As stated earlier, the need study for hydropower is not confined to the basin, but is analyzed by market areas that are tied together by transmission lines. The demand for power from all sources is increasing so rapidly that no economic

projections are necessary in most areas to ascertain that hydropower should be considered in all reservoirs. Justification of such installations is another matter since hydroelectric installations often cannot compete with thermal power. Some consideration may be given in future to need for hydroelectric power for starting large thermal plants in case of "blackouts". Otherwise, hydroelectric needs cannot be studied separately since any power requirements will certainly be met by thermal installations if hydroelectric plants are not justified.

III - Developing the Economic Base Study

Discussion up to this point has been concerned with the reasons for preparing an economic base study and some general illustrations of the use of data developed in the economic study in determining water resource needs. Following are some points that should be considered when setting up an economic base study.

Each study should be carefully designed to fit the particular water resource investigation that is involved. Considerable study may be required to determine the geographic area that could be served by possible projects in the investigated basin, and thus the area that should be included in the economic base study. The number of parameters to be covered and the extent to which they should be developed must be decided on an individual basis. For instance, in some areas only simple population and personal income projects may be necessary, while in others numerous indicators of economic activity should be included.

Usually, more than one Federal, State, or local agency is involved in water resource investigations. Each should be consulted before the scope of the economic base study is selected to make sure it is responsive to their requirements. Coordination with these agencies should be maintained throughout the preparation of the base study. Upon completion, the results should be printed and made available to the public.

Normally, best results will be obtained if the firm or agency making the economic study is thoroughly familiar with the area. It is usually desirable that an agency or group that has no responsibility in determining project needs make the study, thus removing the danger that the study might be slanted toward one project purpose.

Projection of selected parameters will usually be sufficient if extended for 50 years. Many economists object even to 50-year projections because of the uncertainty of many of the assumptions and decisions that must be made. Where possible, economic indicators should be supplied on a county basis to permit aggregation of various subareas within the study basin. The smaller the geographic unit, the larger the probable error in the projections. As a result, they have little significance at the county level and should be used only to form the larger subareas.

Summary

The most objective and effective way to develop water resources commensurate with needs is to analyze these water needs on a basin or regional basis for some future period. In order to estimate these needs with some degree of accuracy, planners must know the future estimated populations, personal income, employment, and similar economic parameters. As the population and standards of living continue to grow, the magnitude of the increase in water demands in each succeeding 10-year period will jump rapidly. Failure to estimate, accept, and plan for this growth would leave an unsatisfied demand and restrict the total development of the economy. Looks into the future help designate reservoir, scenic attractions, and other project sites that should be preserved for future development.

Use of a single set of projections of population and other parameters by all planning agencies helps insure that contemplated projects will be compatible and based on the same patterns of land use or economic development.

Examples given of application of data developed in the economic base study to project needs for flood protection, water supply storage, base for water recreation, etc., are only for illustrative purposes and are not to be taken as specific procedures.

For each area of investigation the economic base study may differ, but to permit sound planning it must be developed.